A R G O N N E   N A T I O N A L   L A B O R A T O R Y

IDAHO DIVISION

REPORT OF EBR-II OPERATIONS

April 1, 1967 through June 30, 1967

ARGONNE NATIONAL LABORATORY

IDAHO DIVISION

IDAHO FALLS, IDAHO

REPORT OF EBR-II OPERATIONS

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I. Operations

A. Summary

Run 25 was begun this quarter, and 823 MWd of power operation were completed. Delays were caused by three factors. The presence of copper in the primary sodium discovered during the previous quarter required further investigation. An anomaly in the power coefficient was noted and experiments were performed in order to investigate this change. A fission gas release occurred. Several low power runs and fuel replacemtns were necessary in order to determine that the source of the fission products was an experimental subassembly which was then removed.

An intensive sodium sampling program for the determination of copper in the primary sodium was in progress at the beginning of the quarter. The concentration of copper in the primary sodium averaged about 1.8 ppm for all samples and continuous operation of the primary sodium purification system for about a month had not produced a noticeable change in this value. Numerous samples taken from the effluent of the purification system showed an average concentration of about 0.69 ppm copper for all samples taken.

Fuel elements which had reached near-rated burnup were replaced in preparation for Run 25. These changes were in addition to the substitution of subassemblies with stainless steel rods for subassemblies with depleted uranium rods in the reflector region performed during the previous quarter. Neutron sources SO-1912 and SO-1911 were removed from the reactor grid and subsequently transferred to the Fuel Cycle Facility for examination of the tantalum clad. An Sb_2O_4 rod was installed for irradiation.

Photographs of the auxiliary electromagnetic pump bus bars repaired during the previous quarter revealed a scratch or possible crack in the cladding of the negative unit which was then removed for inspection. A minor scratch was found which buffing removed quite easily. The bus bar was then reinstalled and the pump was placed in service.

Experimental subassembly X014 was removed at the request of the sponsor and a stainless steel dummy subassembly fabricated from available components was installed in its place. Low power operation for criticals, control rod calibrations and other zero power reactivity measurements followed immediately. On April 18, the approval was received to allow low power criticals and physics tests prior to the start of power operation for Run 25. Formal approval for power operation was received on April 21, and power operations started accordingly. Subsequent power coefficient measurements revealed expected results up to about 5 MWt. Above this value the measured power coefficient was less than previous values. At about 22 MWt, the overall value approached the existing operating limit of 1 Ih/MW. A temporary waiver was requested to continue startup experiments to measure the power coefficient.

A. Summary (continued)

Measurement of the isothermal tesmperature coefficient of reactivity was made by reducing the primary tank temperature to 650°F. The data gave the value of 1.04 Ih/°F.

A repeat of power coefficients was then made incrementally in 2.5 MW steps up to 25 MW. On April 25, approval was received to operate with the new limit of 0.5 Ih/MW at 100% flow, and the power coefficient measurements continued to full power. Control rod calibration rod drop tests were then completed.

From April 29 through May 15, reactor operation was limited to a maximum of 10 MW while physics data was being analyzed. A proposal to continue the investigation of the change in power coefficient was prepared and was approved. After completion of a "Flow Reduction at Constant Power" test and a trapezoidal control rod movement test approval to operate at full power was granted and was begun on May 19.

On May 23, results of sodium sample taken May 18 were reported and indicated the presence of Cs^{137} in significant amounts. Before this could be confirmed by additional analyses, on May 24 the fission gas monitor (FGM) indicated a release of fission products to the primary tank cover gas. Gas samples were immediately taken and the FGM signal was verified. The reactor was then immediately shut down. The three delayed neutron counting channels of the fuel element rupture detector system (FERD) did not indicate any increase in the normal background level of delayed neutrons nor was any reactivity perturbation detected on any of the nuclear channels. Following reactor shutdown, the activity as measured on the FGM indicated an increase of about 1280 times background. Air activity readings above normal were observed in the reactor containment building. Air activity monitors alarmed and the building was evacuated for several hours. By the next morning, the reactor building activity was below RCG-40. The major activity observed in the primary tank gas samples was Xe^{138} which decayed rapidly, leaving other longer-lived gases including Xe^{133} and Xe^{135}.

A two-phase plan of action was formulated for returning the reactor to operation as expeditiously as possible.

Phase I started immediately to assure that all systems were functioning properly. This involved interlock checks and recalibration of radiation and fission product monitors, bringing the reactor critical for a check of control rod position and to carefully measure the worth of control rods.

Phase II followed and involved sufficient low power operation to verify the fission gas leak. The reactor power was raised in 2.5 MWt increments to obtain a fission gas monitor signal to be used as a reference during the location of the defect. On June 11, while operating at 30 MWt, fission gas release Number 2 occurred and again indication was on the fission gas monitor. Reactor shutdown followed immediately and primary tank cover gas samples verified the presence of short-lived fission gases.

A. Summary (continued)

A total of 118 MWd integrated power had accumulated since the first fission gas release. A purge of the primary tank cover gas with clean argon over a several-day period was conducted to reduce its activity in preparation for the following operation. On June 19, the reactor was restarted and the power incrementally raised for a reverification of a fission gas release. Fission gas release Number 3 occurred at 10 MWt during an incremental approach to power, and the FGM again responded to the release quite rapidly. The reactor was shut down after only accruing 16 MWdt since the previous release.

The three most suspected experimental subassemblies (XG05, XA08 and X011) were removed and placed in the storage basket. These subassemblies contained the samples with the highest burnup. After certain loading changes for reactivity adjustment, reactor operation was resumed for a planned 150 MWd's of operation at 30 MWt, to verify that the defective subassembly had been removed from the core. This portion of Run 25 terminated June 27 with no indication of a fission gas release.

Experimental subassembly X011 was returned to the core and reactor operation started June 28 by raising the power in 2.5 MWt steps for a planned 150 MWd run. On the third increment, while operating at 7.5 MWt, a fission gas monitor indicated release Number 4 and the reactor was immediately shut down and subassembly X011 was removed from the core. Experimental subassemblies XA08 and XG05 were reinstalled in the core. The reactor was restarted on the last day of this quarter for a 150 MWd run at 30 MWt to verify that all defective subassemblies had been removed.

B. Chronology of Principal Events

Date	Event
4/ 1/67	Reactor shutdown, bulk sodium temperature at 700°F. Operation approval pending evaluation of copper found in primary sodium. Primary purification system in operation with primary sodium samples being taken at frequent intervals.
4/ 3/67	Exchanged one row 6 subassembly.
	Reactor critical to determine critical position and shut down.
	Fuel handling operations exchanged six core subassemblies and one control rod.
4/ 4/67	Exchanged seven inner blanket B-type subassemblies, one core subassembly, removed Surveillance Subassembly Number 1 from outer blanket, replaced neutron source SO-1912 with neutron source SO-1920.
	Neutron source SO-1912 sent to FCF for examination of tantalum clad.
4/ 5/67	Exchanged five subassemblies including relocation of experimental subassembly X022, completing unrestricted fuel handling.
4/ 6/67	Removed and inspected auxiliary EM pump bus bar. (A photograph indicated a possible crack; however, examination revealed only a small scratch.)
	Shutdown primary purification system for modification to sampling station.
4/ 7/67	Reinstalled auxiliary EM pump bus bar.
4/ 8/67	Load tested auxiliary EM pump.
4/10/67	Interchanged neutron sources SO-1911 and SO-1915 for count rate comparison. Removed neutron source SO-1911 from reactor and sent it to FCF for examination and returned neutron source SO-1915 to original location.
	Removed experimental subassembly X014 and replaced with stainless steel dummy subassembly X000, and exchanged one core subassembly.

B. Chronology of Principal Events (continued)

Date	Event
4/11/67	Completed unrestricted fuel handling.
	Established flow in primary purification system.
4/13/67	Reactor critical at low power for control rod calibrations and zero power reactivity measurements.
4/14/67	Shut reactor down.
4/15/67	Reactor startup and shutdown for training.
4/16/67	Reactor startup and shutdown for training.
4/17/67	Reactor critical for low power physics tests.
	Unrestricted fuel handling - exchanged one core subassembly. Started purge of primary tank argon blanket gas to reduce N_2 contamination.
4/18/67	Transferred experimental subassembly X014 to FCF.
	Approval obtained to begin criticals for Run 25 scheduled for 1545 MWd operation. Stainless steel reflector subassemblies in rows 7 and 8 (88-subassembly core).
4/19/67	Reactor critical for low power physics tests.
4/20/67	Completed purge of primary tank argon blanket gas.
	Received authorization from A.E.C. for power operation.
4/21/67	Started reactor for Run 25. Obtained power coefficient measurements during approach to power. At 25 MW, measured power coefficient dropped below 1.0 Ih/MW. Reactor power reduced to 10 MW for physics tests.
	Shut reactor down and started cooling primary bulk sodium to 650°F to measure the isothermal temperature coefficient of reactivity.
4/22/67	Started reactor to determine isothermal temperature coefficient with primary bulk sodium at 650°F.
	Shut reactor down and started heatup of primary bulk sodium to 700°F.

B. Chronology of Principal Events (continued)

Date	Event
4/23/67	Primary bulk sodium temperature at 700°F.
4/24/67	Started reactor for power coefficient measurements.
4/25/67	Permission received to change operating limit requiring overall average power coefficient to be above 1.0 Ih/MW at 100% flow. The new limit is to be 0.5 Ih/MW at 100% flow. Started reactor and completed power coefficient measurements up to 30 MW.
4/26/67	Started reactor for control rod calibrations, power coefficient, and rod drop measurements. Reactor power at 35 MWt.
4/27/67	Reactor power raised to 45 MW for power coefficient and rod drop measurements.
4/28/67	Continued physics measurements up to 45 MWt.
4/29/67	Reactor at 10 MW.
4/30/67	Established primary purification system flow.
5/ 1/67	Operating reactor per ID-33, Run 25. A 10 MW maximum limitation placed on reactor operation.
5/ 4/67	Operating reactor under 10 MW maximum power limitation.
5/ 9/67	Started FUM modifications, general inspection and cleanup of internal piping.
5/10/67	Reactor power reduced to 500 kW in preparation for low power physics test.
5/11/67	Sent Surveillance Subassembly Number 1 to FCF.
	Performed low power physics tests and returned reactor to 10 MW.
5/13/67	Shut reactor down to inspect the FUM argon system primary tank nozzle (A-3) for sodium condensation.
	Reactor restarted and power operation resumed under 10 MW.

B. Chronology of Principal Events (continued)

Date	Event
5/15/67	Reduced reactor power to 500 kW to period calibrate control rod Number 1 and portions of control rod Numbers 4 and 11.
	Started "Constant Power and Flow Reduction" Test.
5/17/67	Reactor power at 45 MW; generator synchronized with NRTS loop.
5/18/67	Reactor power at 40 MW to conduct trapezoidal control rod movements for reactor physics measurements.
5/19/67	Increased power to 45 MW to continue Power Run 25.
5/22/67	Lost FERD loop Channel B indication. Reduced power. Switched Channel B detector output to Channel 2-A and returned reactor to 45 MW, and placed generator back in operation.
5/23/67	FUM modifications and general maintenance completed.
	Received tentative report that May 18 sodium sample contained Cs^{137}. Took another primary sodium sample.
5/24/67	Fission gas release (Number 1) indicated on fission gas monitor (FGM). Cover gas sample taken and indicated greater than 10 times normal. Evacuated reactor building due to high air activity. Shut reactor down. Primary flow maintained at 100%. A total of 507 MWd accumulated since beginning of Power Run 25. Monitored reactor cover gas activity and maintained limited access into reactor building.
5/25/67	Reactor building opened for normal entry. Reactor cover gas activity normal. Plant in standby with primary system at 700°F.
	Purged hydrogen from main generator casing in order to perform maintenance on seals.
5/26/67	Started checkout of FUM after modifications and installation of MARK III gripper.
5/27/67	Reactor critical for calibration of control rods and then shut down the reactor.

B. Chronology of Principal Events (continued)

Date	Event
5/28/67	Completed 25 transfers with dummy subassembly for checkout of FUM MARK III gripper.
5/29/67	Started reactor and increased power in steps of 2.5 MW to obtain a fission gas monitor signal to be used as a reference during location of defective subassembly.
5/30/67	Shut down reactor with no increase in cover gas activity noted.
5/31/67	Performed air leak rate test on main generator casing.
6/ 2/67	Started cleaning large shield plug seal trough.
6/ 3/67	Completed cleaning large plug seal trough after removing several hundred pounds of alloy and dross.
6/ 4/67	Started reactor to obtain a fission gas monitor signal to be used as a reference during location of defective subassembly. Power to be increased in 2.5 MW increments.
6/ 5/67	Reactor scrammed from 12.5 MW due to NRTS site power outage.
6/ 6/67	Reactor power raised to 17.5 MW.
6/ 7/67	Reactor power raised to 20 MW.
6/ 9/67	Filled generator casing with hydrogen.
	Reactor power raised to 30 MW.
6/10/67	Generator synchronized with NRTS loop.
	Small sodium fire in primary purification cell caused by small leak in a valve bellows in the sodium sampling waste line. Put out fire and evacuated reactor building. Took air sample in purification cell. Reactor building air activity slightly higher than normal. Checked reactor building for contamination, and then returned reactor building access to normal.

B. Chronology of Principal Events (continued)

Date	Event
6/10/67	Fission gas monitor recorder indication went full scale. Evacuated reactor building and reduced reactor power to 500 kW. Gas samples indicated normal activity. High fission gas reading was due to instrument malfunction. Reactor power was returned to 30 MW.
6/11/67	Fission gas release (Number 2) indicated on fission gas monitor (FGM). Gas release verified by primary gas sample.
	Reactor shut down. A total of 625 MWd accumulated since the beginning of Power Run 25; 118 MWd since the May 24 gas release.
6/12/67	Restricted fuel handling in progress.
6/13/67	Established flow through new secondary sodium plugging loop.
	Started annual leak rate test of personnel air lock.
	Started cleaning small shield plug seal trough.
6/14/67	Completed cleaning small plug seal trough.
	Started purge of primary tank argon blanket gas to reduce background fission gas activity.
6/17/67	Terminated leak test of personnel air lock.
6/19/67	Completed purge of primary tank argon blanket gas. Reactor started and power increased incrementally to 10 MW per plan of action. Fission gas release (Number 3) indicated on fission gas monitor (FGM) and shut reactor down. Reactor operation of 16 MWh since June 11 gas release.
6/20/67	Started unrestricted fuel handling - exchanged two row 6 subassemblies for reactivity adjustment.
6/21/67	Removed experimental subassemblies XG05, XA08 and X011 from the core and placed them in the storage basket. Completed unrestricted fuel handling.
	Reactor critical - increasing power in 2.5 MW increments to 30 MW or until fission gas release.

B. Chronology of Principal Events (continued)

Date	Event
6/22/67	Reactor power at 30 MW for 150 MWd's of operation.
6/27/67	Shut reactor down for unrestricted fuel handling. A total of 150 MWd's accumulated reactor operation since fission gas release Number 3, no release during this period of operation.
	Reinstalled experimental subassembly X011 into reactor core.
6/28/67	Started reactor and increased power in 2.5 MW increments to 7.5 MW per current plan of action.
	Fission gas release (Number 4) indicated on fission gas monitor (FGM). Shut reactor down and started unrestricted fuel handling. Replaced experimental subassembly X011 in reactor core with subassembly C-2031.
6/29/67	Reinstalled experimental subassemblies XA08 and XG05 into reactor core. Completed unrestricted fuel handling.
	Reactor started and increased reactor power to 30 MW in 2.5 MW increments.
6/30/67	Reactor power at 30 MW. Generator synchronized with NRTS loop.

C. <u>Production Summary</u> (Fiscal Year)

	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Total For Fiscal Year
Maximum Possible Power Production (Days x 45 MWt)	4140	4185	4050	4095	16,470
Power Production (MWd)	1310	2366	0	823	4499
Plant Factor (%)	31.5	56.7	0	19.25	27.3
Power Production (Days)	35	60	0	56	151
Reduced Power Operation					
Analysis of Power Coefficient of Reactivity Change				(27)	
Analysis of Fission Gas Release				(21)	
Full Power Operation				(8)	
Non-Power Production (Days)					
1) Fuel Handling (Days)		7	22		29
2) Low Power Tests (Days) (Physics, Kinetics, etc.)		6	12	10	28
3) Routine Maintenance (Days) (Also conducted concurrently with other categories)					
4) Fuel Surveillance (Days)	27				27
5) Special Maintenance Repairs, etc.					
Turbine Repair, Oscillator Rod Installation, Freeze Seal Trough Cleaning (Days)	30	19			49
Primary Auxiliary Pump Repair and Inspection (Days)			10		10
6) Manufacturing Rows 7 and 8 Stainless Steel Subassemblies			46		46
7) Analysis of Copper in Primary Sodium				12	12
8) Analysis of Fission Gas Release				13	13
Total Days	92	92	90	91	365

D. Plant Performance

1. Power Production

The reactor was operated for a total of 850 MWd this quarter. Operating History Data is given in Tables I, II and III. Graphs of Critical Time, Generator On Time; Reactor ΔT, Thermal Power, Electrical Power; and Integrated Thermal and Electrical Power are given in Figures 1 through 9. The summary of EBR-II scrams from power is given in Table IV.

2. Primary System

a. Primary Pumps

The graphs of clutch current, generator power, pump speed and flow, Figures 10 through 15, indicate no appreciable change in pump performance.

b. Primary Auxiliary Pump

The pump operated continuously this quarter. The flow with primary pumps shut down shown on the graphs referred to in the above section indicate that this pump is operating normally.

c. Coolant Temperatures

During this quarter, there were short periods of operation at many different power levels. To show the resulting wide variations of subassembly temperatures only two, and in some cases one, core position temperature is plotted on each figure. See Figures 17 through 51.

When the power level varied during any given day the temperature plotted is that for the longest period of constant power.

The increase in number of driver fuel subassemblies for Run 25 as compared with Run 24 caused a decrease in most subassembly outlet temperatures. The decrease was highest for rows 1 and 2 (about 20° for full-loaded subassemblies) while the decrease in row 6 was about 5°F. This is the expected result of increasing the core size, i.e. due to flux flattening the power production at the core center is reduced with respect to the power production at the edge of the core.

On May 16 and 17 the primary coolant flow was reduced from 100 to 54% in steps while the reactor power level was held constant. Figures 52 through 56 show the effect on subassembly outlet temperatures. The temperature increased as the flow was decreased, but deviated from the inverse proportionality which would be expected for such flow changes in a single insulated channel. For some subassemblies, the outlet temperature at reduced flow is less than would be expected and for some it is more. Part of this deviation is due to radial heat transfer between adjacent subassemblies.

OPERATING HISTORY DATA

April, 1967

Date	Reactor Critical Time	Cumulative Critical Time	Gross Thermal Energy	Cumulative Gross Thermal Energy	Gross Electrical Energy	Cumulative Gross Electrical Energy	Generator on Time	Cumulative Generator on Time	Thermal Power Range Max.	Thermal Power Range Min.
	Hrs	Hrs	MWht	MWht	NWhe	MWhe	Hrs	Hrs	MW	MW
1	0	8470.2	0	293936	0	77323	0	5921.5	0	0
2	0	8470.2	0	293936	0	77323	0	5921.5	0	0
3	0	8470.2	0	293936	0	77323	0	5921.5	0	0
4	0	8470.2	0	293936	0	77323	0	5921.5	0	0
5	0	8470.2	0	293936	0	77323	0	5921.5	0	0
6	0	8470.2	0	293936	0	77323	0	5921.5	0	0
7	0	8470.2	0	293936	0	77323	0	5921.5	0	0
8	0	8470.2	0	293936	0	77323	0	5921.5	0	0
9	0	8470.2	0	293936	0	77323	0	5921.5	0	0
10	0	8470.2	0	293936	0	77323	0	5921.5	0	0
11	0	8470.2	0	293936	0	77323	0	5921.5	0	0
12	0	8470.2	0	293936	0	77323	0	5921.5	0	0
13	15.8	8486.0	0	293936	0	77323	0	5921.5	.5	0
14	14.5	8500.5	3	293939	0	77323	0	5921.5	.5	0
15	1.3	8501.8	0	293939	0	77323	0	5921.5	50 kW	0
16	0.5	8502.3	0	293939	0	77323	0	5921.5	63 kW	0
17	7.7	8510.0	2	293941	0	77323	0	5921.5	0.325	0
18	0	8510.0	0	293941	0	77323	0	5921.5	0	0
19	4.4	8514.4	1	293942	0	77323	0	5921.5	0.4	0
20	0	8514.4	0	293942	0	77323	0	5921.5	0	0
21	16.0	8530.4	126	294068	0	77323	0	5921.5	25	0
22	1.0	8531.4	0	294068	0	77323	0	5921.5	50 kW	0
23	0	8531.4	0	294068	0	77323	0	5921.5	0	0
24	8	8539.4	73	294141	0	77323	0	5921.5	20	0
25	17.6	8557.0	371	294512	0	77323	0	5921.5	30	0
26	11.5	8568.5	232	294744	0	77323	0	5921.5	35	0
27	24.0	8592.5	748	295492	0	77323	0	5921.5	45	6.5
28	24.0	8616.5	468	295960	0	77323	0	5921.5	45	.05
29	24.0	8640.5	258	296219	0	77323	0	5921.5	35	6.6
30	24.0	8664.5	193	296412	0	77323	0	5921.5	10	6.5
31										

TABLE II

OPERATING HISTORY DATA

May, 1967

Date	Reactor Critical Time	Cumulative Critical Time	Gross Thermal Energy	Cumulative Gross Thermal Energy	Gross Electrical Energy	Cumulative Gross Electrical Energy	Generator on Time	Cumulative Generator on Time	Thermal Power Range Max.	Thermal Power Range Min.
	Hrs	Hrs	MWht	MWht	NWhe	MWhe	Hrs	Hrs	MW	MW
1	24.0	8688.5	143	206555	0	77323	0	5921.5	10	.05
2	24.0	8712.5	223	296778	0	77323	0	5921.5	10	7
3	16.0	8728.5	118	296897	0	77323	0	5921.5	7.5	0
4	21.0	8749.5	178	297075	0	77323	0	5921.5	10	0
5	24.0	8773.5	202	297277	0	77323	0	5921.5	10	1
6	24.0	8797.5	140	297417	0	77323	0	5921.5	6	5.5
7	24.0	8821.5	144	297561	0	77323	0	5921.5	6	6
8	24.0	8845.5	144	297705	0	77323	0	5921.5	10	6
9	24.0	8869.5	240	297945	0	77323	0	5921.5	10	0
10	22.7	8892.2	226	298172	0	77323	0	5921.5	10	0
11	20.6	8912.8	123	298296	1	77324	1	5922.6	10	0
12	24.0	8936.8	240	298536	1	77324	1	5922.6	10	10
13	24.0	8960.8	221	298757	1	77324	1	5922.6	10	.5
14	21.0	8981.8	202	298959	1	77324	1	5922.6	10	0
15	23.0	9004.8	225	299184	1	77324	1	5922.6	25	0
16	22.8	9027.6	498	299683	1	77324	1	5922.6	41.5	0
17	24.0	9051.6	708	300391	79.1	77403.1	6.5	5929.1	45	10
18	22.0	9073.6	835	301226	212.9	77616	17.5	5946.6	44	0
19	22.0	9095.6	548	301774	129	77745	11.4	5958.0	45	0
20	24.0	9119.6	1080	302854	324	78069	24.0	5982.0	45	45
21	24.0	9143.6	1080	303934	324	78393	24.0	6006.0	45	45
22	23.0	9166.6	937	304872	281	78674	21.8	6027.8	45	0
23	24.0	9190.6	1079	305951	323	78997	24.0	6051.8	45	45
24	12.5	9203.1	542	306493	169	79166	12.3	6064.1	45	0
25	0	9203.1	0	306493	0	79166	0	6064.1	0	0
26	0	9203.1	0	306493	0	79166	0	6064.1	0	0
27	4.5	9207.6	0	306493	0	79166	0	6064.1	.05	0
28	0	9207.6	0	306493	0	79166	0	6064.1	0	0
29	10.5	9218.1	16	306509	0	79166	0	6064.1	2.5	0
30	8	9226.1	20	306529	0	79166	0	6064.1	2.5	0
31	0	9226.1	0	306529	0	79166	0	6064.1	0	0

OPERATING HISTORY DATA

June, 1967

Date	Reactor Critical Time	Cumulative Critical Time	Gross Thermal Energy	Cumulative Gross Thermal Energy	Gross Electrical Energy	Cumulative Gross Electrical Energy	Generator on Time	Cumulative Generator on Time	Thermal Power Range Max.	Thermal Power Range Min.
	Hrs	Hrs	MWht	MWht	NWhe	MWhe	Hrs	Hrs	MW	MW
1	0	9226.1	0	306529	0	79166	0	6064.1	0	0
2	0	9226.1	0	306529	0	79166	0	6064.1	0	0
3	0	9226.1	0	306529	0	79166	0	6064.1	0	0
4	21	9247.1	91	306620	0	79166	0	6064.1	7.5	0
5	22	9269.1	200	306820	0	79166	0	6064.1	12.5	0
6	24	9293.1	352	307172	0	70166	0	6064.1	17.5	12.5
7	24	9317.1	456	307628	0	79166	0	6064.1	20	17.5
8	22.6	9339.7	438	308066	0	79166	0	6064.1	20	0
9	22.3	9362.0	439	308505	0	79166	0	6064.1	30	0
10	24	9386.0	666	309171	111	79277	13	6077.1	30	.5
11	3.5	9389.5	75	309246	21	79298	2.5	6079.6	30	0
12	0	9389.5	0	309246	0	79298	0	6079.6	0	0
13	0	9389.5	0	309246	0	79298	0	6079.6	0	0
14	0	9389.5	0	309246	0	79298	0	6079.6	0	0
15	0	9389.5	0	309246	0	79298	0	6079.6	0	0
16	0	9389.5	0	309246	0	79298	0	6079.6	0	0
17	0	9389.5	0	309246	0	79298	0	6079.6	0	0
18	0	9389.5	0	309256	0	79298	0	6079.6	10	0
19	3.5	9393.0	16	309262	0	79298	0	6079.6	0	0
20	0	9393.0	0	309262	0	79298	0	6079.6	0	0
21	3.3	9363.3	3	309265	0	79298	0	6079.6	2.5	0
22	24	9420.3	543	309808	116	79414	13.5	6093.1	30	2.5
23	24	9444.3	720	310528	199	79613	24	6117.1	30	3.0
24	22	9466.3	640	311168	166	79779	20	6137.1	30	0
25	24	9490.3	720	311888	199	79978	24	6161.1	30	30
26	24	9514.3	720	312608	199	80177	24	6185.1	30	30
27	9	9523.3	253	312861	69	80246	85	6193.6	30	0
28	4.5	9527.8	11	312872	0	80246	0	6193.6	7.5	0
29	14.3	9542.6	142	313014	16	80262	2	6195.6	25	0
30	24	9566.6	683	313697	190	80452	24	6219.6	30	25
31										

TABLE IV

SUMMARY OF EBR-II SCRAMS FROM POWER

April 1 through June 30, 1967

Date	Time	Level	Trip	Remarks
4/25/67	0950	10 MW	Bulk Sodium low level	*Instrument malfunction
4/25/67	1215	20 MW	Bulk sodium low level	*Instrument malfunction
4/26/67	2215	30 MW	Bulk sodium high level	*Instrument malfunction
5/ 3/67	1642	7.5 MW	Power loss	NRTS power disturbance
5/10/67	1943	10 MW	Low pressure cooling water to primary pump MG-sets	Plugged strainers
5/14/67	1000	10 MW	Reactor flow low	Voltage regulator malfunction
5/14/67	1210	10 MW	Reactor flow low	Slidewire for flow deviation circuit momentarily opened. Could have resulted from dust partical between brush and slidewire
5/22/67	1903	45 MW	Reactor building isolation	Receiver panel temperature too high - external cooling added to panel
6/ 5/67	1620	12.5 MW	Voltage dip	NRTS power disturbance
6/ 8/67	2152	20 MW	Argon blanket high pressure	**Equipment malfunction
6/ 9/67	1848	20 MW	Voltage dip	NRTS power disturbance
6/24/67	2013	30 MW	Reactor flow rate-of-change	Vacuum tube failure in sensing amplifier

*The malfunctioning component is not accessible for immediate repair. A replacement sodium level system is undergoing operational tests.

**A valve failed in the argon system for the fuel handling machine.

c. Coolant Temperatures (continued)

For subassembly 6C4, it was estimated that the decrease in outlet coolant temperature at 50% flow due to radial heat transfer to adjacent row 7 subassemblies could be from 10 to 18°F. That is, at 22.2 MWt (50% power) and 50% of full flow, the temperature rise in 6C4 should be 200° (if there is no heat loss) as compared with the 100° rise at 100% flow. For the adjacent row 7 subassemblies the temperature rise is much lower, and heat transferred from row 6 subassemblies to row 7 could be enough to cause the row 6 temperature rise to be 190° to 182°F at the 50% flow condition. However, the rise as measured at 53.5% flow is 160°. Subassembly 7A3 indicates the reverse situation. That is, it has a temperature rise higher than would be calculated if the temperature rise were inversely proportional to flow.

Higher outlet temperature in 7A3 than 7D4 is thought to be due to the fact that the thermocouple for 7A3 is positioned above the side toward the center of the core whereas the thermocouple for 7D4 is above the outer edge. Flow in blanket subassemblies is channeled (no mixing). The strong radial temperature gradient in row 7 subassemblies is shown by the difference in temperature reported by these two thermocouples. The data for 7F4 is erratic, probably due to the noise level on this particular thermocouple.

d. Primary Sodium Chemistry

The vacuum distillation sampling equipment was removed from the primary sodium sampling station on April 1 and argon purged sampling equipment installed. The equipment is capable of receiving samples in 10 ml Pyrex beakers, aluminum tubes, extrusion vessels or similar containers. All are filled from the top and allowed to overflow. Samples may be taken from either upstream or downstream of the primary cold trap. Initially the equipment was in the primary cold trap room, but was later moved into the purification control room (ICC-3) with only the waste sodium container in the purification cell. The sampling station is shielded with lead brick. Minor difficulties such as plugged valves, remote operators, argon gas seals and heater failures were encountered in startup of the system, but in general the performance of the equipment has been satisfactory. On June 10 a bellows seal valve in the waste sodium line failed and permitted radioactive sodium to leak into the area behind the shield. A sodium fire ensued which spread smoke generally throughout the reactor building. Thereafter, the sampling procedure was expanded to require the person taking the sample to wear a respirator or Scott Air Pack and have a qualified coolant operator standing by for assistance in case of emergency. The waste sodium container was filled on June 30.

A summary of pertinent data on primary sodium samples taken during the quarter is shown in Tables V through VII. Sample designation is as follows: "A" samples were taken upstream of the primary cold trap, "B" samples were taken downstream of the primary cold trap, and "F. T. P." samples were taken through the Fuel Transfer Port.

TABLE V

PRIMARY SODIUM SAMPLES (APRIL, 1967)

Date	Sample	No.	Container	Purpose
4-1	FTP	5	Beaker	Cu
1	A	2	Beaker	Cu
1	B	5	Beaker	Cu
2	FTP	6	Beaker	Cu
2	A	11	Beaker	Cu
2	B	12	Beaker	Cu
3	A	11	Beaker	Cu
3	B	11	Beaker	Cu
4	A	3	Beaker	Cu
11	A	1	Beaker	Cu
12	A	2	Beaker	Cu
12	A	1	Al Tube	H_2, O_2
12	B	2	Beaker	Cu
13	A	1	Beaker	Cu
13	B	1	Beaker	Cu
17	A	2	Beaker	Cu
18	A	3	Beaker	Cu
18	B	3	Beaker	Cu
19	A	5	Beaker	Cu
19	B	4	Beaker	Cu
24	A	1	Beaker	Cu

TABLE VI

PRIMARY SODIUM SAMPLES (MAY, 1967)

Date	Sample	No.	Container	Purpose
5-1	A		Extrusion	Carbon
4	A		Extrusion	Carbon
5	A		Beaker	Cu
8	A		Beaker	Cu, Activity
11	A		Al Tube	Carbon Potential
17	A		Beaker	Cu, Activity
19	A		Beaker	Cu, Activity
24	A		Beaker	Cu, Activity
25	A		Beaker	Cu, Activity
26	A		Al Tube	Historical
27	B	2	Beaker	Cu
27	A	2	Beaker	Cu
29	A		Al Tube	Hydrogen, Oxygen

TABLE VII

PRIMARY SODIUM SAMPLES (JUNE, 1967)

Date	Sample	No.	Container	Purpose
6-1	A	1	Beaker	Cu
1	A	1	Beaker	Activity
2	A	1	Extrusion	Activity
4	A	2	Beaker	Cu
4	A	2	Beaker	Activity
5	A	2	Beaker	Cu
5	A	3	Beaker	Activity
6	A	1	Beaker	Cu
6	A	1	Beaker	Activity
7	A	1	Beaker	Cu
7	A	1	Beaker	Activity
7	A	1	Extrusion	Activity
8	A	1	Beaker	Activity
9	A	2	Beaker	Activity
11	A	1	Beaker	Activity
19	A	1	Beaker	Cu
21	A	2	Al Tubes	H_2, O_2, Carb. Potential
28	A	1	Beaker	Activity
28	A	1	Beaker	Cu
30	A	1	Extrusion	

Seven historical samples of primary sodium, dating from March, 1963 through December, 1966 were sent to ANL in Lemont for carbon analysis.

The following analyses were received from samples submitted to ANL Lemont.

Date Taken	ppm Oxygen	ppm Hydrogen
2/27/67	6, 7	3.1, 3.8
3/13/67	5, 9	5.9, 5.1
4/12/67	12, 14	4.9, 10.3

The primary sodium plugging temperatures, purification flow, pump current and pump discharge pressure are presented graphically in Figures 58, 59, and 60.

e. Primary System Cover Gas

The operation of the continuous in-line chromatograph was generally good. It does, however, require frequent attention. During fuel transfer into the primary tank or fuel transfer port cleanup there is a marked increase in the hydrogen content of the cover gas, probably as a result of moisture in the subassembly going in. The hydrogen content decreases to normal levels in a few hours. The data summarized in Table VIII is taken from the chromatograph recorder chart.

TABLE VIII

ANALYSES OF PRIMARY COVER GAS

	April	May	June
ppm H_2			
High	300	400	250
Low	5	5	4
Average	20	20	15
ppm O_2			
High	0	300*	0
Low	0	0	0
Average	0	0	0
ppm N_2			
High	25,000	1,100	9,600
Low	4,000	500	4,000
Average	5,000	600	6,000

*Instrument failure

The concentrations of radioactive components of the primary cover gas are shown in Figures 60 through 68. Normally, three samples per day were taken; however, during periods shortly after a fission gas release as many as ten per eight-hour shift were taken. Only the daily high figure is graphed.

f. Rotating Plug Seals

During June, both the large and small plug seal troughs were cleaned with steel brushes. There were 143 pounds and 68 pounds removed from the large and small plugs, respectively. In both cases the majority, estimated 90-95%, of the material removed was metal.

3. Copper in Primary Sodium

The sampling system described in the previous Quarterly Report (January through March, 1967) was utilized for intensive sampling of the primary cold trap influent and effluent until late on April 3. Sampling of bulk sodium through the Fuel Transfer Port (FTP) was continued also. The chemical analysis results for copper in these samples are presented in Table IX.

To give a better weighting of data than that given only by samples taken after April 1, 1967, nineteen values preceding this date at 1030 for the FTP and ten values preceding this date at 2100 for PI-A were added to make up Table X. Over the entire period of sampling, no trends up or down were detectable, indicating, for the period shown in the table that there are no time-dependent concentration variations.

The results of averaging the data in Table IX indicate that the cold trap is removing copper from the sodium. Table X, showing 28 values for each of the three points, reinforces this conclusion.

In preparing Table X, two very high values (24.25 and 9.95) for the FTP were discarded. We believe that this is justified because a relatively high copper concentration was found in a sample of sodium and sodium oxide scraped from the surfaces of the gripper guide tube in the fuel transfer port. Even though the dip sampler used for taking samples of bulk primary sodium through the FTP was designed so as to minimize the possibility of sample contamination, complete assurance cannot be given that contamination did not occur.

The above-mentioned sample of scrapings was found to contain 39 ppm of copper. It is suspected that this copper may have been carried, as minute copper oxide particles, from the copper mesh packing of the gas purifier in the FUM argon system. Consideration is being given to removal of the gas purifier, thus eliminating potential copper contribution from this source.

The primary sodium sampling equipment was modified for radioactive service. This work was completed on April 10, except for the installation of lead shielding which was deferred pending checkout of the equipment. This sampling equipment is an adaptation, for radioactive service, of that used earlier for the intensive sampling of cold trap influent and effluent. Samples can be taken in 10 ml Pyrex beakers from either the PI-A (cold trap influent) or the PI-B (cold trap effluent) sampling point. Sodium samples were taken from each sampling point on April 12 and 13 for checkout of the sampling system. Operation was satisfactory and, therefore, installation of shielding was completed. The samples were analyzed for copper content, with the results tabulated in Table XI.

TABLE IX

COLD TRAP PERFORMANCE IN COPPER REMOVAL

Sample Vessels - 10 ml Pyrex Beakers

Date	Time	FTP* ppm Cu
4/1/67	1030	3.55
4/1/67	1500	1.32
4/1/67	2000	0.72
4/1/67	2220	1.44
4/2/67	0055	0.70
4/2/67	0450	0.97
4/2/67	1310	0.54
4/2/67	1625	0.79
4/2/67	2140	0.60

All values averaged 1.18 ppm

Average without highest value - 0.88 ppm

Date	Time	PI-A** ppm Cu
4/1/67	2100	0.90
4/1/67	2325	0.50
4/2/67	0210	0.87
4/2/67	0440	0.40
4/2/67	0650	1.20
4/2/67	2040	0.74
4/2/67	2215	1.05
4/3/67	0100	1.20
4/3/67	0245	0.81
4/3/67	0425	1.32
4/3/67	0625	0.73
4/3/67	0754	0.79
4/3/67	0955	0.67
4/3/67	1140	0.86
4/3/67	1440	0.79
4/3/67	1705	1.22
4/3/67	1855	1.04
4/3/67	1950	0.88

All values averaged 0.88 ppm

Date	Time	PI-B*** ppm Cu
4/1/67	1125	0.45
4/1/67	1330	0.26
4/1/67	1540	3.34
4/1/67	1925	0.15
4/1/67	2200	0.59
4/2/67	0045	0.46
4/2/67	0250	0.79
4/2/67	0540	0.25
4/2/67	0730	0.62
4/2/67	0920	0.42
4/2/67	1050	0.25
4/2/67	1345	0.31
4/2/67	0540	2.37
4/2/67	1735	0.74
4/2/67	1925	0.37
4/2/67	2000	0.54
4/2/67	2130	0.54
4/3/67	0015	0.25
4/3/67	0200	0.82
4/3/67	0345	0.65
4/3/67	0545	0.48
4/3/67	0705	1.95
4/3/67	0900	0.25
4/3/67	1105	0.37
4/3/67	1345	0.93
4/3/67	1630	0.61
4/3/67	1733	0.29
4.3/67	1923	0.30

All values averaged 0.69 ppm

Average without values greater than 2.0 is 0.52 ppm

* FTP - Fuel Transfer Port

** PI-A - Cold Trap Influent

*** PI-B - Cold Trap Effluent

TABLE X

COPPER IN PRIMARY SODIUM

Date	Time	FTP* ppm Cu	Date	Time	PI-A** ppm Cu	Date	Time	PI-B*** ppm Cu
3/28/67	1550	1.91	3/24/67	0050	1.54	4/1/67	1125	0.45
3/28/67	1730	1.01	3/24/67	1420	0.31	4/1/67	1330	0.26
3/28/67	1940	0.72	3/24/67	1600	0.86	4/1/67	1540	3.34
3/28/67	2125	2.02	3/24/67	2100	0.87	4/1/67	1925	0.15
3/29/67	0230	3.09	3/24/67	2245	0.73	4/1/67	2200	0.59
3/29/67	0355	1.12	3/27/67	1355	0.88	4/2/67	0045	0.46
3/29/67	1825	0.77	3/27/67	1730	1.58	4/2/67	0250	0.79
3/29/67	2000	0.46	3/27/67	2010	0.95	4/2/67	0540	0.25
3/30/67	0050	1.41	3/28/67	0215	0.99	4/2/67	0730	0.62
3/30/67	0220	0.23	3/30/67	2030	1.21	4/2/67	0920	0.42
3/30/67	0415	2.28	4/ 1/67	2100	0.90	4/2/67	1050	0.25
3/30/67	0620	0.65	4/ 1/67	2325	0.50	4/2/67	1345	0.31
3/30/67	1100	0.42	4/ 2/67	0210	0.87	4/2/67	1540	2.37
3/30/67	1300	0.41	4/ 2/67	0440	0.40	4/2/67	1735	0.74
3/30/67	2150	0.45	4/ 2/67	0650	1.20	4/2/67	1925	0.37
3/31/67	0200	1.41	4/ 2/67	2040	0.74	4/2/67	2000	0.54
3/31/67	0230	2.46	4/ 2/67	2215	1.05	4/2/67	2130	0.54
3/31/67	1530	0.63	4/ 3/67	0100	1.20	4/3/67	0015	0.25
3/31/67	2145	0.55	4/ 3/67	0245	0.81	4/3/67	0200	0.82
4/ 1/67	1030	3.55	4/ 3/67	0425	1.32	4/3/67	0345	0.65
4/ 1/67	1500	1.32	4/ 3/67	0625	0.73	4/3/67	0545	0.48
4/ 1/67	2000	0.72	4/ 3/67	0754	0.79	4/3/67	0705	1.95
4/ 1/67	2220	1.44	4/ 3/67	0955	0.67	4/3/67	0900	0.25
4/ 2/67	0055	0.70	4/ 3/67	1140	0.86	4/3/67	1105	0.37
4/ 2/67	0450	0.97	4/ 3/67	1440	0.79	4/3/67	1345	0.93
4/ 2/67	1310	0.54	4/ 3/67	1705	1.22	4/3/67	1630	0.61
4/ 2/67	1625	0.79	4/ 3/67	1855	1.04	4/3/67	1733	0.29
4/ 2/67	2140	0.60	4/ 3/67	1950	0.88	4/3/67	1923	0.30

	FTP	PI-A	PI-B
All values averaged =	1.16 ppm	0.92 ppm	0.69 ppm
Values > 2 out	0.88 ppm	0.92 ppm	0.52 ppm

* FTP - Fuel Transfer Port

** PI-A - Cold Trap Influent

*** PI-B - Cold Trap Effluent

3. Copper in Primary Sodium (continued)

TABLE XI

COPPER IN PRIMARY SODIUM

April 12 and 13, 1967

Date	Time	Sample Point	Cu (ppm)
4/12/67	1030	PI-A	0.95
4/12/67	1230	PI-B	0.33
4/12/67	1430	PI-A	0.61
4/12/67	1715	PI-B	0.28
4/13/67	1845	PI-A	0.49
4/13/67	2240	PI-B	0.72

A series of sodium samples was taken from the secondary sodium system on April 14, using the same sampling equipment as had been used for the primary sodium sampling of April 1 through 3. The purpose of this work was to check the scatter of analytical results for samples from a large system which should be uniform and constant in copper concentration. The results appear in Table XII.

TABLE XII

SECONDARY SODIUM COPPER ANALYSIS

April 14, 1967

Time	Copper (ppm)
1755	0.33
1835	less than 0.25
1920	0.27
2010	0.28
2040	0.44
2115	0.27
2145	0.36
2215	less than 0.25
2245	0.41
2315	0.25
2345	less than 0.25

3. Copper in Primary Sodium (continued)

On April 18 and 19, 1967, samples were taken from the primary cold trap influent and effluent with different flow rates through the cold trap. The copper analysis results for these samples are presented in Table XIII. There is no obvious effect of flow rate upon copper concentrations.

TABLE XIII

COLD TRAP COPPER REMOVAL

April 18 and 19, 1967

Date	Time	Sample Point	Cold Trap Flow Rate (ppm)	Copper (ppm)
4/18/67	1215	PI-A	15	0.45
4/18/67	1550	PI-B	15	1.89
4/18/67	1730	PI-A	15	0.49
4/18/67	1850	PI-B	15	0.45
4/18/67	1945	PI-A	15	0.43
4/18/67	2040	PI-B	15	0.40
4/19/67	0930	PI-A	10	0.43
4/19/67	1030	PI-B	10	0.31
4/19/67	1140	PI-A	10	1.20
4/19/67	1230	PI-B	10	0.64
4/19/67	1310	PI-A	5	0.32
4/19/67	1345	PI-B	5	0.38
4/19/67	1405	PI-A	5	0.46
4/19/67	1430	PI-B	5	less than 0.25
4/19/67	1450	PI-A	5	0.66

Samples taken for copper analysis during the first half of May, 1967 were used instead for analyses of fission product activities, as a consequence of the EBR-II fission product release incidents. Analytical results for copper in subsequent samples taken during May and June are given in Table XIV.

TABLE XIV

ANALYSES FOR COPPER IN PRIMARY SODIUM

Sample Date and Time		Sample Point	Copper, ppm
5/17/67	1300	PI-A*	0.24
5/27/67	0945	PI-B**	0.24
5/27/67	1220	PI-A	0.34

* Sampling line from cold trap inlet piping.
** Sampling line from cold trap outlet piping.

3. Copper in Primary Sodium (continued)

TABLE XIV (continued)

ANALYSES FOR COPPER IN PRIMARY SODIUM

Sample Date and Time		Sample Point	Copper, ppm
5/27/67	1405	PI-B	0.44
5/27/67	1510	PI-A	0.56
6/ 1/67	1450	PI-A	0.57
6/ 4/67	1350	PI-A	0.22
6/ 5/67	1655	PI-A	0.23
6/ 6/67	1030	PI-A	0.18
6/ 7/67	2200	PI-A	0.14
6/ 8/67	2200	PI-A	0.14
6/ 9/67	1245	PI-A	0.16
6/19/67	1515	PI-A	0.22
***			
6/28/67	1455	PI-A	0.32

*** Samples could not be taken. Sampling system out of service for replacement of waste sodium container.

4. Secondary System

a. Secondary Sodium Pump

Figures 69 through 71 show the secondary sodium flow and the power to flow ratio. No significant change in pump performance has been noted.

b. Secondary Sodium Chemistry

The vacuum distillation sampling equipment was removed from the secondary sodium sampling station late in April and a continuous flow through sampler (extrusion vessel) was installed. The new sampling station also incorporates provisions for filling the aluminum tubes for carburization potential, FCF containers and a loop containing a continuous oxygen analyzer. Flow through the new equipment was initiated in mid-June and checkout of the equipment continued through June. The oxygen analyzer was not started as it could not be maintained at the desired temperature.

b. Secondary Sodium Chemistry (continued)

The plugging temperatures measured were as follows:

Date	Plugging Temperature	Date	Plugging Temperature
4/17/67	265°F	4/24/67	275°F
4/18/67	265°F	4/25/67	280°F
4/20/67	270°F	4/26/67	270°F
4/21/67	280°F	4/27/67	250°F
4/22/67	275°F	4/28/67	255°F
4/23/67	275°F		

Throughout the months of May and June, the secondary sodium purification system operated continuously at a flow of from 9 to 15 gpm.

A summary of pertinent data on secondary sodium samples taken during the report quarter are shown in Table XV.

TABLE XV

SECONDARY SODIUM SAMPLES

Date	Container	No.	Purpose
4/ 5/67	Al Tube	1	H_2, O_2
4/ 6/67	Al Tube	1	Carbon Potential
4/ 6/67	Stainless Steel Cell	1	Historical
4/14/67	Beaker	12	Cu
4/27/67	Beaker	1	Activity
6/30/67	Al Tube	1	Carbon Potential
6/30/67	Al Tube	1	H_2, O_2

The sample taken April 4, 1967 and sent to Lemont for analysis produced the following duplicate results; ppm oxygen 9 and 6, ppm hydrogen 3.5 and 4.8.

c. Secondary Sodium Cover Gas

More reliance was placed on results obtained from the continuous in-line chromatograph analyzing the argon from the secondary sodium surge tank because many of the grab sample analyses were reported as being air contaminated. The following data were taken from the chromatograph recording chart.

c. Secondary Sodium Cover Gas (continued)

TABLE XVI

ANALYSES OF SECONDARY COVER GAS

	April	May	June
ppm H_2			
High	15	12	15
Low	5	5	5
Average	10	10	10
ppm N_2			
High	1,500	1,600	1,800
Low	1,000	1,000	1,000
Average	1,200	1,500	1,200

5. Steam System

a. Pressure and Temperature

Figures 72 through 74 are graphs of steam temperature and pressure. No unusual conditions were noted.

b. Water Treatment

1) Power Cycle Streams

Tables XVII and XVIII present a summary of analytical data taken from the steam system.

TABLE XVII

CONDENSATE pH

	April	May	June
Condensate			
High	9.6	9.7	9.3
Low	6.8	8.8	8.8
Average	9.2	9.4	9.2

b. Water Treatment (continued)

TABLE XVII (continued)

CONDENSATE pH

	April	May	June
No. 2 Heater			
High	9.7	9.8	9.3
Low	9.2	9.2	8.8
Average	9.5	9.6	9.1
Boiler Feedwater			
High	9.6	9.7	9.3
Low	8.5	8.5	9.1
Average	9.3	9.6	9.2
Boiler Blow Down			
High	9.3	9.3	9.2
Low	9.3	8.8	8.9
Average	9.3	9.2	9.0

TABLE XVIII

HYDRAZINE AND DISSOLVED OXYGEN

	No. 2 Heater			Boiler Feedwater		
	April	May	June	April	May	June
ppm N_2H_4						
High	.02	.03		.3	.3	.07
Low	.02	.01		.04	.01	.02
Average	.02	.02		.06	.2	.04
ppm O_2						
High	22	15	20	15	15	13
Low	20	5	10	5	5	5
Average	21	5	15	10	5	5

b. Water Treatment (continued)

2) Condenser Cooling Water

The acid addition system has not been replaced and the pH control of the cooling water was by manual control of the acid addition from 200-pound barrels into the pump suction bay at the cooling tower.

Table XIX is a summary of the pH and CrO_4 content of the cooling water.

TABLE XIX

CONDENSER COOLING WATER pH AND CrO_4

	April	May	June
pH			
High	8.4	8.5	8.0
Low	6.3	5.9	6.3
Average	7.0	6.4	6.7
CrO_4			
High	20	20	17
Low	9	10	4
Average	13	12	11

A test unit for the reduction of the chromate ion in the cooling water blow down was in operation much of this report quarter. A ratio of about four pounds of sulfur dioxide to one of chromate was established.

II. Fuel Handling

The final loading changes for Run 25 were completed by mid-April. These changes consisted of removal of subassemblies having burnup of 0.7 a/o or greater to provide spent fuel input to the Fuel Cycle Facility and to increase length of Run 25 from 700 MWd to 1545 MWd. Fifteen fuelled subassemblies were removed from the grid.

The investigation of the fission gas release required the removal of XG05, XA08, and X011 from the reactor to the storage rack. It was suspected one of these three experimental subassemblies had failed. Subassembly X011, which was identified as the source of the fission gas release, was finally left in the storage rack. An equal-worth subassembly was substituted for X011. The other subassemblies, XG05 and XA05, were returned to their original locations in the reactor.

A total of 167 individual transfers were made either to or from the reactor grid or the storage basket during this quarter.

A. Experimental Irradiations

One experimental subassembly, X011, was removed from the reactor to the storage basket.

B. Subassembly Inventory

A total of 21 subassemblies, which included a materials subassembly (SURV-I) and the bare pin control rod (L418X), were transferred to the Fuel Cycle Facility for examination, disassembly and/or reprocessing of spent subassemblies. Antimony source rod SO-1911 was transferred for examination. Thirty-five (35) reprocessed subassemblies were received from the Fuel Cycle Facility.

Seventy-two (72) subassemblies were available on June 30 and twenty-four (24) were available on March 31. This includes those in the Fuel Cycle Facility and in the storage basket.

C. Grid Loading Changes

Reactor grid loading changes for increase of Run 25 to 1545 MWd were completed by mid-April. A summary of the core loading for Run 25 is given below.

Core Size (Fuelled and Experimental Subassemblies)	88
Experimental Irradiation Subassemblies	16

D. Subassembly Utilization

The average utilization of the subassemblies removed for Power Run 25 is 84%. The average utilization of the eighteen spent subassemblies transferred to the Fuel Cycle Facility was 72%.

TABLE XX

ADDITIONAL LOADING CHANGES FOR RUN 25

Grid Loading Changes

April 3 to April 17, 1967

Date	Remove	Maximum Burnup	From	Install
4/ 3/67	A-834	----	6A1	B-366
4/ 3/67	C-263	.91	3A2	C-270
4/ 3/67	C-264	.87	3C1	C-2028
4/ 3/67	C-266	.91	3F2	C-286
4/ 3/67	C-267	.78	4B1	C-299
4/ 3/67	C-268	.78	4C1	C-2025
4/ 3/67	C-269	.78	4E1	C-2027
4/ 3/67	L-434	.85	5B3	L-448
4/ 4/67	C-261	.90	5D2	C-2030
4/ 4/67	B-336	.93	6C3	B-358
4/ 4/67	B-335	.88	6B2	B-362
4/ 4/67	B-334	.95	6C4	B-355
4/ 4/67	B-337	.88	6C5	B-363
4/ 4/67	B-338	.88	6D5	B-364
4/ 4/67	B-339	.88	6E5	B-365
4/ 4/67	B-340	.88	6F5	B-367
4/ 4/67	SURV-1	----	12B1	U-1405
4/ 4/67	U-1039	----	13F6	U-1605
4/ 5/67	X022	----	7C2	A-834
4/ 5/67	A-820	----	7C4	X022
4/ 5/67	B-366	----	6A1	A-820
4/ 5/67	B-325	----	6F2	B-361
4/ 5/67	C-219	.52	3D2	C-282
4/10/67	X014	----	4E2	X000
4/10/67	C-262	----	4A1	C-2036
4/17/67	C-253	1.05	3F1	C-262

Grid Loading Changes

June 20 to June 29, 1967

Date	Remove	Maximum Burnup	From	Install
6/20/67	B-356	----	6C1	A-835
6/20/67	B-360	----	6F1	A-836
6/21/67	XG05	----	4C2	C-2026
6/21/67	X011	----	4F2	C-2005
6/21/67	XA08	----	4F2	C-2031
6/27/67	C-2005	----	2F1	X011
6/28/67	X011	----	2F1	C-2005
6/29/67	C-2031	----	4F2	XA08
6/29/67	C-2026	----	4C2	XG05
6/29/67	A-835	----	6C1	B-356
6/29/67	A-836	----	6F1	B-360

Source Transfers

April 4 to April 10, 1967

Date	Remove	From	Install
	St.T. 1905		
4/ 4/67	SO-1912	13F6	U-1039
4/ 4/67	U-1605	8A4	SO-1912
			St.T. 1905
4/ 4/67	SO-1912	8A4	SO-1920
4/10/67	SO-1915	8E5	SO-1911
4/10/67	SO-1911	13D6	SO-1915
4/10/67	SO-1911	8E5	SO-1915
4/10/67	SO-1911	8E5	To FCF

TABLE XXI

TRANSFERS TO AND FROM FUEL CYCLE FACILITY

SPENT SUBASSEMBLIES TRANSFERRED TO FCF

Subassembly Number	Grid Position	Maximum Burnup	Date
C-219	3D2	.52	4/10/67
C-237	1A1	1.00	4/ 5/67
C-253	3F1	1.05	4/18/67
C-261	5D2	.90	4/10/67
C-263	3A2	.91	4/ 6/67
C-264	3C1	.87	4/ 6/67
C-266	3F2	.91	4/ 6/67
C-267	4B1	.78	4/ 7/67
C-268	4C1	.78	4/ 7/67
C-269	4E1	.78	4/ 7/67
B-325	6F2	--	4/28/67
B-334	6C4	.95	4/19/67
B-336	6B2	.88	4/11/67
B-336	6C3	.93	4/11/67
B-337	6C5	.88	4/21/67
B-338	6D5	.88	4/24/67
B-339	6E5	.88	4/25/67
B-340	6F5	.88	4/25/67
L-418X	5A3	--	6/21/67
L-434	5B3	.85	4/ 5/67
SURV-1	12B1	--	5/ 9/67

REPROCESSED SUBASSEMBLIES FROM FCF

Subassembly Number	Date
C-2005	6/14/67
C-2026	4/20/67
C-2033	4/27/67
C-2034	4/27/67
C-2036	4/ 6/67
C-2037	4/28/67
C-2038	4/28/67
C-2039	4/28/67
C-2040	4/28/67
C-2041	5/ 8/67
C-2042	5/ 8/67
C-2043	5/ 8/67
C-2044	5/ 9/67
C-2045	6/ 8/67
C-2046	6/ 9/67
C-2047	6/ 9/67
C-2048	6/ 9/67
C-2049	6/ 9/67
C-2050	6/12/67
C-2051	6/12/67
C-2052	6/23/67
C-2053	6/23/67
C-2054	6/24/67
C-2055	6/30/67
C-2056	6/30/67
C-2057	6/30/67
C-2058	6/30/67
B-368	4/12/67
B-369	4/12/67
B-370	4/12/67
B-371	4/17/67
B-372	4/18/67
B-373	4/30/67
B-375	4/21/67
B-376	5/ 8/67

TABLE XXII

INNER AND OUTER BLANKET SUBASSEMBLIES TO FUEL CYCLE FACILITY

(Depleted Uranium)

Subassembly Number	Grid Position	Date
U-1039	8F1	6/16/67
U-1040	8B2	5/ 3/67
U-1043	8E1	5/ 5/67
U-1072	8B7	5/ 4/67
U-1116	8C3	6/12/67
U-1154	8A2	5/ 1/67
U-1164	8C2	5/ 3/67
U-1171	8E7	6/13/67
U-1206	---	5/ 1/67
U-1235	8D1	5/ 1/67
U-1255	8D7	6/13/67
U-1293	8A1	6/15/67
U-1295	8C1	5/ 4/67
U-1315	8A7	5/ 5/67
U-1385	8E2	5/ 8/67
U-1404	8F2	5/ 3/67
U-1406	8D3	5/ 4/67
U-1425	8C7	5/ 6/67
U-1435	8B1	5/ 6/67
U-1450	8D2	6/14/67
U-1539	8F7	6/14/67

III. Reactor Physics

A significant change in power coefficient of reactivity was observed on Run 25 as compared with Run 24. At low powers (< 5 MWt) the power coefficient was normal; however, its value decreased with increasing power until at 22 MWt the overall coefficient averaged 1 Ih/MW. To increase power from 500 kW to 45 MW, 39 Ih were required as compared to 66 Ih for Run 24. Measurement of the overall reactivity decrement for 0 to 45 MWt is given in Table XXIII. Part of the reactivity decrement is caused by control rod shaft expansion and is a function of control rod position. In order to compare results, measurements of power decrement are normalized to a rod bank position of 11.00 inches.

TABLE XXIII

REACTIVITY DECREMENT BETWEEN 0 AND 45 MWt

	Run 25				Run 24	
	4/26	4/28	4/28	5/19		
Raw Data (Inhours)*	42.3	38.4	38.0	39.1	64.3	56.5
Corrections						
Initial Power	0	0	0	0	0	0
Temperature	+2.0	0	0	+0.8	0	0
Burnup	-6.0	0	0	0	0	0
Rod Bank**	0	0	0	-1.1	2.4	8.1
Corrected Data	38.3	38.4	38.0	38.8	66.7	64.6
MWd	0	40.0	60.0	306.0	0	555.0
Rod Bank	11.0	11.0	11.0	11.0	12.0	14.0

* Raw data is the difference in control rod position as determined from the "book" value times the period calibration correction.

** Rod bank correction is referred to the 11.0 inch rod position versus power.

The change in power reactivity decrement has been attributed to an increase in the bowing component brought about by the insertion of the stainless steel inner blanket. The temperature distribution in these elements is such that row 8 exhibits reverse bowing, which increases the effect of bowing on the core subassemblies.

III. Reactor Physics (continued)

The pertinent reactor variables during this portion of Run 25 are as follows:

Excess Reactivity	initial	352	Inhours
	as of 6/30	223	Inhours
Control Rod Bank	initial	11.0	Inches
	as of 6/30	11.4	Inches
Controlling	initial	8.88	Inches
		6.95	Inches
	as of 6/30	8.11	Inches
Overall Power Coefficient		0.85	Ih/MW
Integrated Power		854	MWd

An experiment was performed to estimate the fuel expansion component of the power coefficient by operating the reactor at two different power levels (41.5 and 22.5 MW) with the same reactor ΔT (122°). This was accomplished by lowering the flow to 54% for the lower power level.

Since bowing is attributed to reactor temperature effects, the difference in reactivity measured is due only to the difference in fuel expansion caused by fuel temperature. The measured value of eight inhours is in good agreement with calculations and verified the presence of a prompt negative term in the power coefficient.

The isothermal temperature coefficient was measured and was found to be 1.04 Ih/°F which is quite close to the value of 1.01 Ih/°F measured for the initial reactor loading having 70 core subassemblies.

The reactivity versus power is given in Figure 75. Numbers in circles indicate % flow. Unnumbered circles are 100% flow values.

On May 24, a fission gas alarm signal from charged wire monitor occurred. No increase was noted on any of the 3 FERD (delayed-neutron monitor) channels. Reactor coolant temperatures and nuclear instruments remained normal. Eight minutes after the charged wire monitor alarm occurred, reactor building air activity monitors exceeded normal. Primary tank cover gas samples confirmed the presence of fission product gasses.

Tests of control rod performance, instrumentation and reactivity effects indicated that there had been no significant changes in the reactor core. The reactor was then operated to find the lowest power level at which fission product

III. Reactor Physics (continued)

gases could be detected to serve as a reference when removing various subassemblies to determine which subassembly contained the defect. It was estimated from studies of the fission product gas data that the failure could be one of the high burnup test specimens or the equivalent of 185 MARK I-A fuel pins. Details of these analyses can be found in ANL-7349 and Report of Fission Product Release. Table XXIV is a summary of the fission gas release data.

Subassemblies containing high burnup test specimens (XG05, XA08 and X011 maximum burnup 5.8, 4.4 and 3.5 a/o, respectively) were removed from the core and the reactor was operated at power. The power level was again increased in steps of 2.5 MWt with operation for 1 hour at each step to the maximum power of 30 MWt. No fission gas was observed as the reactor was operated on June 29 and 30, the start of a planned 150-MWd run at 30 MW.

IV. Experimental Irradiations

A. Experimental Subassembly Locations

Figures 76, 77 and 78 show the locations of all experimental subassemblies in the grid during the three significant phases of Run 25, as well as the locations of other special subassemblies, control and safety rods and standard EBR-II driver subassemblies.

B. Experimental Subassembly Contents and Exposure Status

Descriptions of experimental capsules and exposures in all experimental subassemblies that have been resident in the reactor to date are given in Table XXV.

V. Systems Maintenance, Improvements and Tests

A. Mechanical and Electrical

1. Primary Tank Annulus

A leak rate test was performed to determine any large gas leaks from the space between the inner and outer primary tank. The test was not performed under highly controlled conditions since only large leakage rates were being looked for.

The test was performed at 2 inches of water pressure during the six-hour test period; there was no change in pressure, which indicates the leak rate (if any) was small.

TABLE XXIV

SUMMARY OF FISSION GAS RELEASE IN EBR-II

Fission Gas Release No.	Date	Differential (MWd)	Count Rate Before Release (cps)	Max. Count Rate After Release (cps)	Gas-Sample Activity Just Prior to and Max. After Fission Gas Release: Xe^{133} (cpm)	Xe^{135} (cpm)
1	5/24/67	525[a]	12.5	35,000[e]	2.4×10^3 to[d]	1.8×10^3 to[d]
2	6/11/67	115	5	85	7.0×10^3 to 8.3×10^3	8.5 to 10^2 to 5×10^3
3	6/19/67	0.66	0.5	580	4.0×10^2[c] to 1.4×10^5	8[c] to 5.5×10^3
4	6/28/67	0.46[b]	1.5	295	2×10^4 to 1.5×10^5	1.1×10^3 to 3.0×10^3

(a) From the start of Run 25.

(b) A 150-MWd run with experimental irradiation subassemblies XG05, XA08, and X011 removed, with no gas release preceding this run.

(c) Primary tank cover gas purged with fresh argon to reduce residual activity prior to this run.

(d) Samples too hot to count under standard geometry. Approximately 450-fold increase in activity.

(e) Extrapolated value.

2. Reactor Building Penetration Leak Rate Tests

The following penetrations were tested and found satisfactory during this report period.

	Penetration	Leakage Rate (standard ft^3/day)
1.	Purge exhaust valve (R13-VR-319)	1.84
2.	Personnel air lock door #2 (inner)	2.00
3.	Personnel air lock door #1 (outer) and lock	12.00

3. Primary Sodium Purification System

A larger sodium waste container was fabricated and installed for use in the sampling station. A new sample line was connected into the old PI-B plugging loop piping and routed through the shield plug for taking samples downstream of the crystallizer tank.

The throttle and plugging valves on the PI-A loop were removed and inspected for copper deposition (none was found), new bellows were installed in the valves, and the system was returned to normal.

The cold trap bypass valve (R1-VC-677) was jammed shut. A jack screw was fabricated and the valve was forced open. The gate had apparently wedged in the seat since the valve is now operating satisfactorily.

The vacuum line on the surge tank plugged with what appeared to be sodium oxide. The line was cleaned and some minor piping changes were made to facilitate cleaning the line.

4. Auxiliary EM Pump

A photograph of the repaired auxiliary EM pump negative bus bar revealed a mark that appeared to be a crack. The bus bar was removed and inspected. The mark was a scratch approximately 3 mils deep and 3 mils wide. The entire lower section of the bus bar was checked with dye penetrant. No cracks or other defects were found. The bus bar was reinstalled and the system has been returned to normal.

5. Primary Sodium Level Measuring Assembly

A sodium level measuring unit that is now under test was installed in the primary tank nozzle D-1. This nozzle previously contained the periscope that was used during initial filling of the primary tank with sodium.

6. FUM Argon System

Minor modifications including re-running new tubing were completed on the FUM argon system analyzer. This work was done to help minimize potential air leaks into the FUM argon system.

The breakers in RE-3 (power to the FUM and FUM argon system) were checked and found to trip satisfactorily. Several breakers were interchanged to match wire size with breaker size to avoid any overloading of the circuits.

The a.c. turbo-compressor was given a preventative maintenance inspection. A considerable amount of sodium oxide was deposited in the motor. The oxide was cleaned out of the motor and the bearings were checked by measuring "end-play" and feeling for rough spots. The unit appeared to be in satisfactory condition and has been returned to service. A spare motor was put on order.

A new sodium vapor trap was installed to replace a plugged unit.

The copper bed gas purifier was removed and a new unit was installed. The new unit had the copper replaced with stainless steel mesh. This was done to eliminate any possibility of contaminating the primary sodium with copper.

Valves A, B, F, G, J and W were modified. New bonnets that incorporate an "O" ring seal with the packing seal to help reduce leaks in the system were installed; in addition, heavier duty operator supports were fabricated and installed to help prevent the valves from sticking due to misalignment.

The "Z" valve piping assembly that is located between the vapor trap and the primary tank gas outlet nozzle (A-3) was removed. The valve and piping had a considerable amount of sodium deposited in it and the valve was found to have a deep groove in the ball. The valve was repaired and the assembly was cleaned and reinstalled. In conjunction with this work, the A-3 nozzle was inspected for sodium deposition; only a thin film of sodium was deposited in the nozzle so it was not removed for cleaning.

The entire argon system was leak tested using a soap solution and an argon leak detector.

7. Fuel Unloading Machine (FUM)

A newly designed gripper (MARK III) was installed and has been tested. The MARK III gripper installation was done to try and eliminate the high maintenance required of the old gripper design. "To date" the new gripper has been quite satisfactory.

A thorough clean-up and inspection of the FUM was completed in conjunction with the installation of the MARK III gripper. A new vapor filter

7. Fuel Unloading Machine (FUM) (continued)

was installed. The port and gas inlet and outlet lines were disassembled and cleaned. The subassembly guide tube was cleaned. The unit has now been reassembled and is back in operation.

8. New #2 Interbuilding Coffin (IBC)

The new IBC was received and alignment of it to the FUM was completed.

9. Primary Tank Cover Gas System

Due to suspected gas leaks out of the primary tank, considerable effort was put into leak testing for potential leakage sources. The fission gas monitor, the gas chromatograph and the primary tank rotating port were found to be the biggest offenders. After correcting the leaks found in these systems, the leakage rate from the tank was less than 2 cfh.

10. Storage Basket

New cam rollers were purchased and installed in the Ferguson (rotational) drive. Considerable effort was expended aligning the vertical movement rollers. The unit is in operation, but further alignment work may be necessary.

11. Secondary Sample Stations, Oxygen Meters and Plugging Indicator

The installation of the secondary sample station and the UNC electrochemical oxygen meters (Plant Modification #110) has been completed. Sodium flow was established and the loops de-bugged. Minor modifications were required to solve problems with valve operators, heater circuits and plugged lines.

The installation of the FERD loop plugging indicator test unit was completed and the indicator has been put in operation.

Headers on the inlet line to the oxygen meters are insufficient to heat sodium to UNC's recommended operating temperature. A regenerative heat exchanger will be fabricated and installed in the loop. After the heat exchanger has been installed and checked out, electrochemical tubes will be inserted in the oxygen meters and testing initiated.

The following additions to the sample stations are planned:

a. A flow-through freeze-line sampler capable of sampling sodium in a length of tubing or the extrusion type vessel is currently being tested. Capabilities for rapid forced cooling of the extrusion vessel are currently being tested. Capabilities for rapid forced cooling of the extrusion vessel will be provided to investigate segregation phenomena of impurities in sodium.

b. A vacuum distillation sampler similar to the original unit was installed in the system. Modifications are planned to improve vacuum conditions and increase heat input to the distillation cup.

These additions to the sample station will facilitate more accurate characterization of the secondary sodium and test various sodium sampling techniques.

12. Startup Feedwater Pump

The difficulty in keeping the packing in the pump has continued. The teflon packing that has been in use has had an average running time of about 40 hours. A metallic packing was installed, but it also failed after a short running time.

13. Turbine-Driven Condensate Pump

The governor failed due to a broken spring; the spring was replaced, and the unit is back in operation.

14. Main Generator

Due to a hydrogen leak in the generator, the turbine end of the generator was disassembled and a new seal was installed. The old seal does not appear to be damaged. Several possible minor leaks were corrected and the generator was satisfactorily air tested at 25 psig.

15. Main Turbine

Considerable adjustment on the turbine overspeed governor trip was necessary after receiving it from the GE shop. After the proper adjustments were made, the unit tripped the turbine at about 3920 rpm.

16. Secondary System MG-Set

Since the secondary MG-set has been returned to normal operation, there has been no report of the noise which had been present during previous operation of the unit. It is felt that the difficulty must be in the coupling which sporadically binds and causes the noise.

17. 150-Pound Steam System Check Valve

A new check valve was installed in the 150-pound steam system (Plant Modification #101).

18. Small Steam Bypass Valve (VC-501-B)

A new stem, bushing and packing were installed in the small bypass valve. It is impossible to keep the valve in good working condition and it will be replaced with a new valve when it arrives and the operating schedule permits the time to make the installation.

19. High Pressure Flash Tank

The sight glass failed on the high pressure flash tank and new mica, gaskets and glasses were installed.

20. No. 3 Feedwater Heater

The sight glass failed on the No. 3 feedwater heater and new mica and gaskets were installed.

21. No. 1 Primary MG-Set Eddy Current Coupling

The disassembly of the old coupling (a spare coupling was installed for a 10,000-hour inspection of the old unit) was completed. The unit appears to be in fairly satisfactory condition. Corrosion or erosion of the internal components has not been severe. The bearings were nearly worn out and would possibly have given trouble within the year. New bearings will be installed and the internal components will be treated with a corrosion inhibitor in accordance with the manufacturer's recommendations.

22. Motor-Driven Feedwater Pump Pressure Reducing Valve (P5-VC-596)

The pressure reducing valve has a tendency to stick at about the 3/4 open position. The valve was completely disassembled. A new stem was installed and some minor alignment problems were corrected. No specific reason could be found for the sticking. The valve was reassembled and put back in service. It operated satisfactorily for several weeks, but on occasion it still sticks in the 3/4 open position.

23. Sodium Disposal

Approximately 400 pounds of sodium have been disposed of during this report period. This increased disposal rate has been primarily due to the increased sampling activities.

24. Emergency Power Test

The emergency bus tie and circuit breaker test as described in procedure EP-1 was completed. Several minor discrepancies were found and corrected.

25. 2400 Volt Switchgear

A spare 2400 volt breaker was obtained as a surplus item from Hallam. The breaker performed satisfactorily when tested and has now been put in storage.

B. Instrumentation and Control

1. Auxiliary Power Source for DC Turbine for FUM Argon Cooling System

The DC turbine (DC motor-driven turbine-type blower) was provided to insure cooling under emergency conditions for a subassembly while the subassembly was in residence in the Fuel Unloading Machine (FUM). A set of batteries is employed as the emergency power supply. During certain (non-emergency) operations, it is desirable to operate the DC turbine and because the battery charger lacks capacity to carry both the battery charging load and the turbine, the batteries are discharged. An auxiliary power supply has been designed with sufficient capacity to carry the DC turbine under load. By using programmed relaying, the auxiliary supply will furnish power to the turbine through the emergency power system. With complete power failure, the DC turbine would depend on the batteries for power. Using this scheme, maximum battery capacity is always available when required.

The engineering for this modification has been completed and the power supply fabricated. The installation will be scheduled for early August.

2. Flow Measuring Components for Argon Cooling Gas Flow for Fuel Unloading Machine (FUM)

An orifice and differential pressure transmitter have been installed in the return line to the turbine blower to measure the argon flow in the Argon Cooling System for the Fuel Unloading Machine (FUM). The transmitter was located in the depressed area with readout on the Argon Cooling Console.

3. FERD Trips

The FERD system abnormal trips have been inserted in the reactor shutdown circuit temporarily as added protection in case of a fuel rupture. The three channels were connected in a two-out-of-three coincidence circuit for a reactor scram.

4. Interlocking IBC Port Valve

This modification provided interlocks to the Interbuilding Coffin (IBC) and Fuel Unloading Machine (FUM) systems to perform the following functions.

a. For Opening Port

The new interlocks prevent opening of IBC and FUM valves unless the following set of conditions have been satisfied: (1) the gas pressure has dropped below the pre-set low pressure, (2) the pneumatic seal has been set, and (3) the radiation shield is in the down and sealed position. This action insures a purge of the vessel.

b. For Closing Port

An interlock was added in the "Close Port Circuit" which will prevent closing the port with the gripper still in or out of the vessel. This prevents damaging the FUM gripper by closing of IBC or FUM ports.

c. Maintenance or Emergency Bypass

A key switch was added to bypass the interlocks added for control of the IBC port during maintenance or emergency periods.

In conjunction with this modification, a set of switches was installed at the operating floor level paralleling the IBC port functional switches in the depressed area. This was for operator convenience.

5. Elapsed Time Meter Installed

a. Argon Cooling System AC Turbine

b. Argon Cooling System DC Turbine

c. Primary System Blanket Gas Argon Blower

d. Emergency Air Compressor

e. Emergency Argon Compressor

6. Secondary Sodium Sampling System

A multi-point heater control and a DCEM pump control circuit was assembled and installed for this system. The basic control is "ON-OFF" controlled from thermocouples located on the piping. A scanning system was used to minimize the required number of control amplifiers. The DCEM pump control is a static control regulating current to the pump over a 0 to 200 ampere range at 6 VDC.

7. Reactor Instrumentation (WP 1728)

The new primary tank level device (float) has been installed in the primary tank for proof testing prior to connecting it as a replacement for the existing primary tank level scram device. Its operation is being very closely monitored.

The level device was installed in the primary tank and the load cell interconnected to the power supply and demodulator on 4/2/67. The output of the demodulator was then connected to an MV/I amplifier with a recorder and four monitor switches on the output side of the MV/I amplifier. Electro-mechanical counters were connected to the monitor switches. The monitor switches were set to trip at ± 1 and ± 3 inches level change. The scram set points for the existing instrument are ± 3 inches.

7. Reactor Instrumentation (WP 1728) (continued)

A review of the recorder chart for one week of operation indicated the system was within ± 1/4 inch of the quiescent level at 700°F. This compared reasonably well with the data obtained prior to installation. On 5/2/67 a definite shift was detected, implying a shift of level equal to 7/16 inch. Also eleven +1 unit trips were registered on the counter and one +3 trip. From the recorder chart it was obvious the trips were noise spikes.

The demodulator was removed, modified by installing a new low voltage power supply and reinstalled. The stability of the system was definitely improved.

During the period 6/6/67 to 7/11/67, the level varied around a center of ± 3/8 of an inch for maximum deviation with the major part of the time between ± 1/4 inch of level. Part of the deviation is due to bulk sodium temperature variations from 700°F. A total of twelve trips were indicated with three trips on each of the monitors set for ± 1 and ± 3 inches. The trips occurred during two site power outages and were not due to instrument malfunction.

To date this device appears to be more satisfactory than originally anticipated. If continued operation is as successful, the unit will be used to replace existing equipment.

8. Nuclear Instrumentation (WP 1741)

Equipment was on order during this period. Engineering necessary for installation has been completed.

9. Reactor System Improvements (WP 1742)

a. Temperature Monitoring Devices

Equipment deliveries have been delayed until July, 1967. The seven drawers necessary for the equipment installation have been fabricated and those components available have been mounted in the drawers. Connecting of components has been carried as far as possible. All possible preliminary work has been completed. Installation work has been limited to cable installation which has also been carried as far as possible. The balance of the installation is now scheduled for early September, 1967.

b. Multi-Point Recorders

The multi-point recorders have been received from the manufacturer. A shop calibration was performed on both units. The first unit was installed for readout of the bulk sodium temperatures. The second unit for readout of primary purification system operating parameters. The units replaced have been returned to the manufacturer for a major overhaul. This sub-project can now be considered complete.

c. Miniature Recorders

The recorders are on order with delivery anticipated in late July, 1967. Installation of these units is scheduled for the early part of September, 1967.

10. Selected Parameter System

a. 50-Point System

The 50-point system for monitoring and alarm of reactor core parameters has been assembled, installed and placed in operation. The alarm band was set up for ± 20°F initially, and is gradually being reduced to the final operating band of ± 10°F. Additional startup information is required to finalize the system. A draft of the final topical report has been prepared and should be ready for publication by early September, 1967.

b. 100-Point System

The 100-point system was held up at the manufacturer's due to non-delivery of the incremental tape recorder. The tape recorder has been received and installed on the system. The factory acceptance test was performed and the system did not satisfy all of the requirements. Additional circuit design and/or just debugging will be required before the system can be acceptable. The manufacturer now anticipates a system shipping date of mid-July, 1967.

Installation of the necessary cabling for the 100-point system inputs has continued. All the necessary cable has been installed and terminated at the master patch panel.

11. Fuel Handling System Card Reader

The card reader for the fuel handling system employed center-pivoted contact fingers for sensing the holes in the card to be read. The fingers were worn and errors were being transmitted to the storage system or the card would not be read, which resulted in a loss of operating time. A new card reader was used to replace the old reader. Although the new card reader is from a different manufacturer, the program matches and only minor changes in connector location were required to reconnect to the system.

The card reader was checked in the system column by column, and row by row. The check proved satisfactory and the card reader has been returned to service.

12. Rotating Plug Seal Heaters

Three of the flexible heaters for heating the large plug rotating seal have failed in service. These are the first heaters to have failed since the heaters were all replaced with the stainless steel heaters. The heaters were

12. Rotating Plug Seal Heaters (continued)

cleanly removed with no indication of alloy leakage into the heater. The failure occurred at the point where the flexible lead jacket is joined to the heater.

The heaters were aged in place and the system returned to service.

13. Rod Position Indicators

Three of the rod position indicators have malfunctioned. The problems encountered have been in the mechanical gearing. The units were removed and the gears replaced. These units have continuously require maintenance.

IRRADIATED TO 6-30-67

CAPSULES, FUEL - 194 MK-A
CAPSULES, MTLS. - 106 MK-A
21 MK-B-7
19 MK-B-19
TOTAL 340
NO. OF SUBASSY'S 23

TABLE XXV
SUMMARY OF CAPSULE IRRADIATIONS IN EBR-II
6-30-67

ASSEMBLY	GRID LOCATION	EXPERI-MENTER(S)	GOAL EXPOSURE MWd	FINAL EXPOSURE MWd	STATUS AS OF 6-30-67 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	FUEL CAPSULES: NO OF CAPS & DESIGNATION	FUEL CAPSULES: POWER GENERATION KW/FT MAX	FUEL CAPSULES: POWER GENERATION KW/FT MIN	FUEL CAPSULES: MID-PLANE BURNUP RATES % MWd x 10^{4} MAX	FUEL CAPSULES: MID-PLANE BURNUP RATES % MWd x 10^{4} MIN	FUEL CAPSULES: STATUS AS OF 6-30-67 % BU (MAX)	MATERIAL CAPSULES: NO OF CAPS & DESIGNATION	MATERIAL CAPSULES: MATERIAL	MATERIAL CAPSULES: TYPE OF SAMPLE: BURST TEST	MATERIAL CAPSULES: TYPE OF SAMPLE: TENSILE	MATERIAL CAPSULES: TYPE OF SAMPLE: CREEP RUPTURE	MATERIAL CAPSULES: STATUS AS OF 6-30-67 NVT x 10^{-22} TOTAL FLUX
XA01	8D2	ANL-MET	14,000	3,940*		5-6-65	3-24-66	U-Pu-Fz	19- C93 C97 C98 C99 C100 C101 CA01 CB02 CB03 CB04 CD01 CD02 CG02 CG03 CJ01 CM01 LA02 PA01 PB02	2.7	2.0	1.23	.91	0.48						
XG01	4F2	GE	700	381*		5-6-65	5-23-65	UO_2-$20PuO_2$	6- F1A F1B F1C F1D F1E F1F	16	14	5.78	5.08	0.22						
		GE													4- P1A	347	X	X		0.14
															P1B	347	X	X		
															MT1	HAST X INCO-625 I-800		 X		
															MT2	HAST-X INCO-625 I-800		 X		
XG02	7A1	GE	13,600		10,570	7-16-65		UO_2-PuO_2	1- F0E	5.3		2.1[illegible]		2.2						
XG03	7D1	GE	19,450		10,570	7-16-65		UO_2-PuO_2	2- F0A F0C	5.3	4.6	2.10	1.94	2.2						

TABLE XXV (Cont.)

SUB ASSEMBLY	GRID LOCATION	EXPERI-MENTER(S)	GOAL EXPOSURE MWd	EXPOSURE MWd	STATUS AS OF 6-30-67 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	NO. OF CAPS & DESIGNATION	POWER GENERATION KW/FT MAX	MIN	MID-PLANE BURNUP RATES %/MWd x 10^4 MAX	MIN	STATUS AS OF 6-30-67 %BU(MAX)	MATERIAL CAPSULES: NO. OF CAPS & DESIGNATION	MATERIAL	TYPE OF SAMPLE: BURST TEST	TENSILE	CREEP RUPTURE	STATUS AS OF 6-30-67 NVT X 10^{-22} TOTAL FLUX
XG04	7B1	GE	39,000		10.570	7-16-65		UO_2-PuO_2	2- F0B F0D	5.3	4.6	2.10	1.94	2.2						
XG05	4C2	GE	14.750		9993	9- 3-65		UO_2-PuO_2	9- F2C F2D F2G F2H F2O F2R F2T F2V F2X	15.5	13.5	6.10	5.48	6.1	5- L2A L2C L2E L2G L2I	 I-800 316 L 347 304 321	 X X X X X	 X X X X X		3.8
		ANL			9993			UC-PuC	3- HMV-5 NMV-11 SMV-2	19.3	18.8	5.70	5.50	5.7						
		ANL			9993			U-15Pu-10Zr	2- NC-17 ND-24	8.6	8.5	5.27	5.18	5.3						
XG06	4E2	GE	20.600	9317		9- 3-65	2-20-67	UO_2-PuO_2	12- F2A F2B F2E F2F F2N F2P F2Q F2S F2U F2W F2Y F2Z	15.5	13.5	6.10	5.48	5.7	5- L-2'-K L-2'-M L-2'-O L-2'-P L-2'-Q	 I-800 316 L 347 321 304	 X X X X X	 X X X X X		3.6
		ANL						U-15Pu-10Zr	2- NC-23 ND-23	9.2	8.6	5.63	5.26	5.2						

TABLE XXV (Cont.)

	GRID LOCATION	EXPERI-MENTER(S)	GOAL EXPOSURE MWd	FINAL EXPOSURE MWd	STATUS AS OF 6-30-67 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	FUEL CAPSULES: NO. OF CAPS & DESIGNATION	FUEL CAPSULES: POWER GENERATION KW/FT MAX	FUEL CAPSULES: POWER GENERATION KW/FT MIN	FUEL CAPSULES: MID-PLANE BURNUP RATES MWd x 10^4 MAX	FUEL CAPSULES: MID-PLANE BURNUP RATES MWd x 10^4 MIN	FUEL CAPSULES: STATUS AS OF 6-30-67 (BU MAX)	MATERIAL CAPSULES: NO. OF CAPS & DESIGNATION	MATERIAL CAPSULES: MATERIAL	MATERIAL CAPSULES: TYPE OF SAMPLE: BURST TEST	MATERIAL CAPSULES: TYPE OF SAMPLE: TENSILE	MATERIAL CAPSULES: TYPE OF SAMPLE: CREEP RUPTURE	MATERIAL CAPSULES: STATUS AS OF 6-30-67 NVT X 10^{-22} TOTAL FLUX
	4D3	ANL	18,600	7950		10-27-65	12-5-66	U-15Pu-9Zr	16-	9.4	8.2	5.80	5.10	4.60	3-					3.2
									ND-25						As-9	V-20Ti			X	
									ND-26						As-10	HAST-X			X	
									ND-27						As-11	304			X	
									ND-28											
									ND-29											
									ND-30											
									ND-31											
									ND-32											
									ND-33											
									ND-34											
									ND-35											
									ND-37											
									ND-39											
									ND-41											
									ND-43											
									ND-44											
XA08	4F2	ANL	19,800		8171	12-13-65		(Pu-U)C	8-	26.0	17.2	6.20	5.40	5.1	9-					3.2
									HMV-1						As-1	V-20Ti	X			
									HMV-4						As-2	V-20Ti	X			
									HWMP-1						As-3	HAST-X	X			
									HWMV-1						As-4	HAST-X	X			
									NMP-2						As-5	304	X			
									NMV-4						As-6	V-20Ti			X	
									NMV-7						As-7	HAST-X			X	
									NMV-12						As-8	304			X	
															As-12	V-20Ti			X	
		GE													2-					3.2
															MT-3	I-800	X	X		
															MT-4	I-800	X	X		
X009	4A2	UNC	5,130	5355		3-24-66	11-14-66	PuC-UC	3-	28.0	19.6	6.07	5.90	3.25						
									UNC-78											
									UNC-79											
									UNC-80											
		ANL						PuC-UC	3-	27.0	18.1	6.17	5.40	3.30	3-					2.1
									SMP-1						As-14	V-20Ti		X		
									SMV-1						As-15	V-20Ti		X		
									VMV-1						As-27	304		X		
		ANL						UO_2-PuO_2	2-	16.5	15.6	5.65	5.47	3.03						
									SOV-5											
									SOV-6											
		PNWL (ANL)						PuO_2-S/S	2-	10.0	6.5	6.55	6.55	3.40	4-					2.1
									SP-13						A-1	304		X	X	
									SP-14						A-2			X	X	
															A-[illegible]			X	X	
															A-[illegible]			X	X	

TABLE XXV (Cont.)

SUB ASSEMBLY	GRID LOCATION	EXPERIMENTER(S)	GOAL EXPOSURE MWd	FINAL EXPOSURE MWd	STATUS AS OF 6-30-67 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	NO. OF CAPS & DESIGNATION	POWER GENERATION KW/FT MAX	MIN	MID-PLANE BURNUP RATES %/MWd x 10^4 MAX	MIN	STATUS AS OF 6-30-67 %BU(MAX)	MATERIAL CAPSULES: NO. OF CAPS & DESIGNATION	MATERIAL	TYPE OF SAMPLE: BURST TEST	TENSILE	CREEP RUPTURE	STATUS AS OF 6-30-67 NVT x 10^{-22} TOTAL FLUX
X009 (CONT.)		GE													2- L-4-C L-4-D	 316 316	 X X	 X 		2.1
X010	7F3	GE	19,600		7501	3-24-66		UO_2-PuO_2	4- FOJ FOK FOL FOM	8.6	7.7	3.18	2.84	2.4						
		ANL			7501										11- As-16 As-17 As-18 As-19 As-20 As-21 As-22 As-23 As-24 As-25 As-26	 V-20Ti V-20Ti V-20Ti HAST-X V-20Ti, 304 HAST-X V-20Ti 304 304 304 304 304	 X	 X X X	 X X	1.3
		PNWL			7501										4- A-3 A-4 A-7 A-8	 304 304 304 304		 X X X X	 X X X X	1.3
X011	2F1	ANL	8,300	5745		5-9-66	6-28-67	UO_2-20PuO_2	7- HOV-4 HOV-10 HOV-15 SOV-1 SOV-3 SOV-7 TVOV-1	23	19.5	6.47	6.15	3.7						

TABLE XXV (Cont.)

[illegible]	GRID LOCATION	EXPERIMENTER(S)	GOAL EXPOSURE MWd	FINAL EXPOSURE MWd	STATUS AS OF 6-30-67 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	NO. OF CAPS & DESIGNATION	POWER GENERATION KW/FT MAX	POWER GENERATION KW/FT MIN	MID-PLANE BURNUP RATES %/MWd x 10^4 MAX	MID-PLANE BURNUP RATES %/MWd x 10^4 MIN	STATUS AS OF 6-30-67 % BU MAX	MATERIAL CAPSULES: NO. OF CAPS & DESIGNATION	MATERIAL	TYPE OF SAMPLE: BURST TEST	TENSILE	CREEP RUPTURE	STATUS AS OF 6-30-67 NVT x 10^{-22} TOTAL FLUX
X011 (CONT.)	2F1	GE	8300	5745		5-9-66	6-28-67	UO_2-20PuO_2	9- F4A F4D F4E F4F F4G F4H F4J F4K F4L	17.9	16.4	6.47	6.15	3.7						
		PNWL						PuO_2-S/S	2- 5P-9 5P-12	11.5	7.5	7.52	7.45	4.3						
		PNWL						UO_2-S/S	1- 5U-14	5.9	5.9	6.12		3.5						
X012	4B2	NuMEC	20.600		3801	8-10-66		UO_2-20PuO_2	19- C-1 C-2 C-3 C-4 C-6 C-7 C-8 C-9 C-10 C-11 C-12 C-13 C-14 C-15 C-16 C-17 C-18 C-19 D-5	15.5	13.5	6.07	5.38	2.3						
X013	3C1	ANL	1,200	1,309		7-17-66	9-7-66								19- As-34	HAST-X	X	X		0.6
															As-35	INCO-625	X			
																V-20Ti		X		
															As-36	INCO-625	X			
																V-20Ti		X		

TABLE XXV (Cont.)

SUB ASSEMBLY	GRID LOCATION	EXPERI-MENTER(S)	GOAL EXPOSURE MWd	FINAL EXPOSURE MWd	STATUS AS OF 6-30-67 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	FUEL CAPSULES: NO. OF CAPS & DESIGNATION	FUEL CAPSULES: POWER GENERATION KW/FT MAX	FUEL CAPSULES: POWER GENERATION KW/FT MIN	FUEL CAPSULES: MID-PLANE BURNUP RATES a/o/MWd x 10^4 MAX	FUEL CAPSULES: MID-PLANE BURNUP RATES a/o/MWd x 10^4 MIN	FUEL CAPSULES: STATUS AS OF 6-30-67 °C BU(MAX)	MATERIAL CAPSULES: NO. OF CAPS & DESIGNATION	MATERIAL CAPSULES: MATERIAL	TYPE OF SAMPLE: BURST TEST	TYPE OF SAMPLE: TENSILE	TYPE OF SAMPLE: CREEP RUPTURE	STATUS AS OF 6-30-67 NVT X 10^{-22} TOTAL FLUX
X013 (CONT)	3C1	ANL	1,200	1.309		7-17-66	9-7-66								As-37	HAST-X	X	X		0.6
															As-38	V-15Ti				
																7.5 CR	X			
																V-20Ti		X		
															As-39	V-15Ti				
																7.5 CR	X			
																V-20Ti		X		
															As-40	V-15Ti				
																7.5 CR	X			
																V-2CTi		X		
															As-41	V-15Ti				
																7.5 CR	X			
																V-20Ti		X		
															As-42	V-15Ti				
																7.5 CR	X	X		
															As-43	V-15Ti				
																7.5 CR	X	X		
															As-44	V-15Ti				
																7.5 CR	X	X		
															As-45	INCO-625	X			
																V-15Ti				
																7.5 CR		X		
															As-46	HAST-X	X	X		
															As-47	304	X	X		
															As-48	304	X	X		
															As-49	304	X	X		
															As-54	V-15Ti				
																7.5 CR	X	X		
															As-55	INCO-625	X			
																V-15Ti				
		PNWL			1309										1-	7.5 CR		X		
															BG-1	GRAPHITE				0.6
X014	4E2	PNWL	**	3674		7-17-66	4-10-67													
															5-					
															A-9	304		X		1.8
															A-10	348		X		
															A-11	348		X		
															A-12	304		X		
															A-13	304 & 348				

TABLE XXV (Cont.)

SUB ASSEMBLY	GRID LOCATION	EXPERI-MENTER (S)	GOAL EXPOSURE MWd	FINAL EXPOSURE MWd	STATUS AS OF 6-30-67 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	NO. OF CAPS & DESIGNATION	POWER GENERATION KW/FT MAX	MIN	MID-PLANE BURNUP RATES a/o /MWd X 10^4 MAX	MIN	STATUS AS OF 6-30-67 %BU(MAX)	MATERIAL CAPSULES: NO. OF CAPS & DESIGNATION	MATERIAL	TYPE OF SAMPLE: BURST TEST	TENSILE	CREEP RUPTURE	STATUS AS OF NVT X 10 TOTAL FL
X014 (CONT)		GE		3674											5-					1.8
															L4A	1-800	X	X		
															L4B	1-800	X	X		
															L4E	347	X	X		
															L4F	304	X	X		
															L4G	321	X	X		
		NRL													5-					
															NRL-1	1-800		X		1.8
																HAST-X		X		
																304, 316		X		
															NRL-2	1-800		X		
																316		X		
															NRL-3	1-800				
																304		X		
																316		X		
															NRL-4	1-800				
																304		X		
																316		X		
															NRL-5	INCO-625		X		
																HAST-X				
																316		X		
		PNWL													2-					
															BG-2	GRAPHITE				1.8
															BG-3	GRAPHITE				
		GE													2-					
															MT-5	1-800	X	X		1.8
															MT-6	1-800	X	X		
X015	4A2	NUMEC	11,000		2146	11-15-66		UO_2-20PuO_2	11-	15.4	14.0	6.04	5.55	1.3						
									B-1											
									B-2											
									B-3											
									B-4											
									B-5											
									B-6											
									B-7											
									B-8											
									B-9											
									B-10											
									B-11											
		GE			2146			UO_2-20PuO_2	2-	14.0	14.0	5.55	5.55	1.2						
									F7C											
									F7D											

TABLE XXV (Cont.)

SUB ASSEMBLY	GRID LOCATION	EXPERI-MENTER(S)	GOAL EXPOSURE MWd	FIRST EXPOSURE MWd	STATUS AS OF 6-30-67 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	FUEL CAPSULES: NO. OF CAPS & DESIGNATION	FUEL CAPSULES: POWER GENERATION KW/FT MAX	FUEL CAPSULES: POWER GENERATION KW/FT MIN	FUEL CAPSULES: MID-PLANE BURNUP RATES (MWd x 10^4) MAX	FUEL CAPSULES: MID-PLANE BURNUP RATES (MWd x 10^4) MIN	FUEL CAPSULES: STATUS AS OF 6-30-67 (LB/MAX)	MATERIAL CAPSULES: NO. OF CAPS & DESIGNATION	MATERIAL CAPSULES: MATERIAL	TYPE OF SAMPLE: BURST TEST	TYPE OF SAMPLE: TENSILE	TYPE OF SAMPLE: CREEP RUPTURE	STATUS AS OF 6-30-67 NVT x 10^{-22} TOTAL FLUX
X015 (cont.)	4A2	ANL	11,000		2146	11-15-66		$(U_{.8}Pu_{.2})C$	4- MHV - 3, TVMV - 1, HMV - 2, NMP - 1	25.0	17.6	6.08	4.10	1.3						
		ANL			2146			MK-IA (METAL)	2- BF02, BF03	7.6	7.6	3.16	3.16	0.7						
X016	4D3	GE	3,000		826	1-13-67									10					0.3
															L-10-A	I-800	X	X		
															L-10-B	I-800	X	X		
															L-10-C	I-800	X	X		
															L-10-D	316	X	X		
															L-10-E	316	X	X		
															L-10-F	316	X	X		
															L-10-G	304	X	X		
															L-10-H	304	X	X		
															L-10-I	347	X	X		
															L-10-J	321	X	X		
		ANL													9					0.3
															AS-29	304	X	X		
															AS-30	Vi-Ti-Cr	X	X		
															AS-31	In-625	X	X		
															AS-32	Hast-X	X	X		
															AS-33	In-625	X	X		
															AS-50	Vi-Ti-Cr	X	X		
															AS-51	304	X	X		
															AS-52	Hast-X	X	X		
															AS-53	Hast-X	X	X		
017	4C3	NuMEC	6,500		2146	11-15-66		UO_2-20PuO_2	11 A1, A2, A3, A4, A5, A6, A7, A8, A9	15.4	13.5	6.04	5.37	1.3						

TABLE XXV (Cont.)

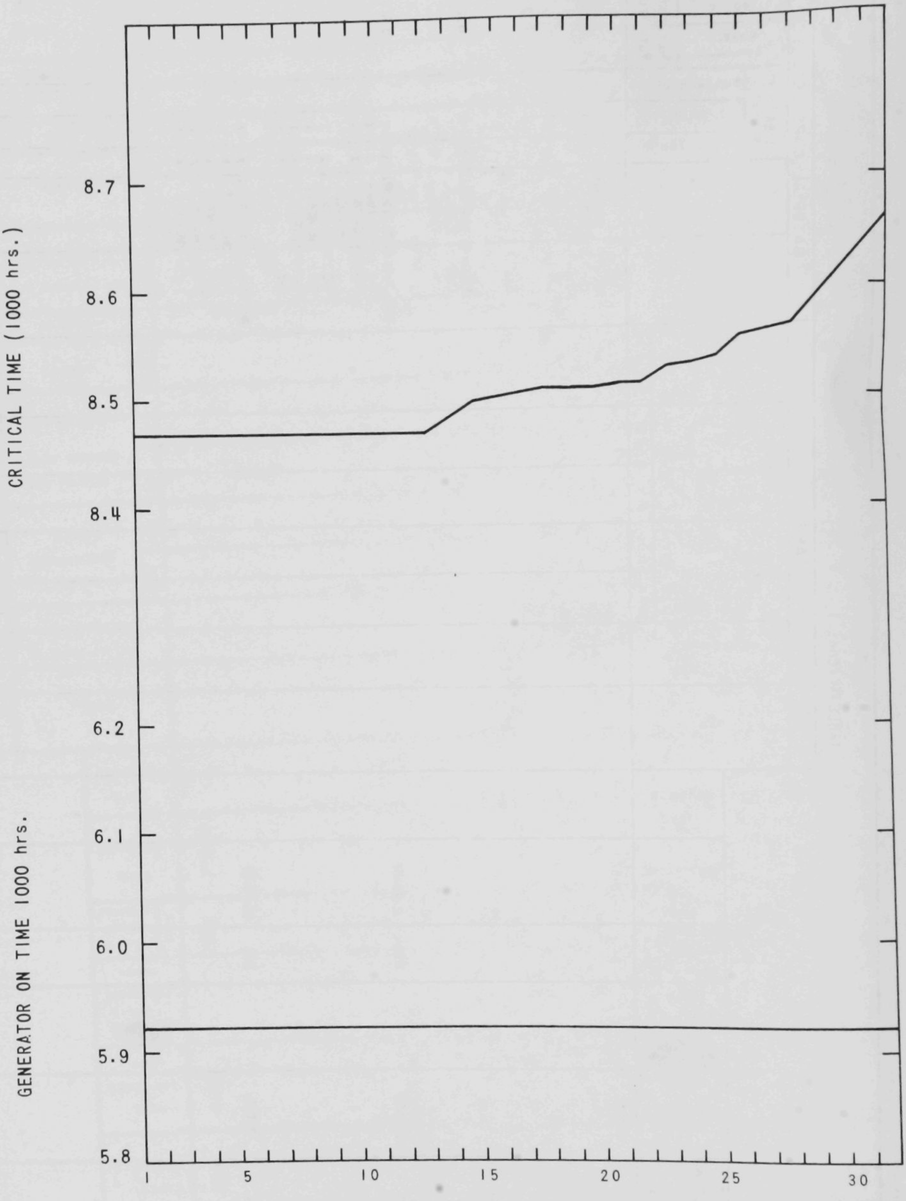
								FUEL CAPSULES							MATERIAL CAPSULES					
																	TYPE OF SAMPLE			
	GRID LOCATION	EXPERI-MENTER (S)	GOAL EXPOSURE MWd	FINAL EXPOSURE MWd	STATUS AS OF 6-30-67 MWd	DATE INSTALLED	DATE REMOVED	FUEL	NO OF CAPS & DESIGNATION	POWER GENERATION KW/FT MAX	POWER GENERATION KW/FT MIN	MID-PLANE BURNUP RATES a/o/MWd x 10^4 MAX	MID-PLANE BURNUP RATES a/o/MWd x 10^4 MIN	STATUS AS OF 6-30-67 %BU(MAX)	NO OF CAPS & DESIGNATION	MATERIAL	BURST TEST	TENSILE	CREEP RUPTURE	STATUS AS OF 6-30-67 NVT X 10^{-22} TOTAL FLUX
X017 CONT.	4C3			6500		11-15-66														
		UNC			2146			$(U_{.8}Pu_{.2})C$	A10 A11 3 87 89 90	26.8	25.2	6.17	5.79	1.3						
		ANL			2146			MK-IA METAL	5 BF04 BF05 BF08 BF09 BF11	8.4	8.2	3.43	3.37	0.7						
X018	2B1	GE	21,300		1456	12-6-66									3 a b c	1800,316 304,316 304,321, 347	X X X	X X X		0.7
		ANL			1456										3 AS56	V20Ti, V15 Ti-7.5Cr	X	X	X	0.7
															AS57	HAST-X 304	X	X	X	
							1								*AS58	V20Ti, V15TI- 7.5 CR	X	X	X	—
		PNWL			1456										BNWL 7-1	304, 316 321, 348		X	X	0.7
X019	6D2	GE	7,500		826	1-13-67		UO_2-20PuO_2	7 F8A F8B F8C F8D F8E F8F F8G	8	7	3.60	3.10	0.3						
		UNC						$(U_{.8}Pu_{.2})C$	3 UNC81 UNC82 UNC83	20	19	4.24	3.92	0.3						

TABLE XXV (Cont.)

SUB ASSEMBLY	GRID LOCATION	EXPERIMENTER(S)	GOAL EXPOSURE MWd	FINAL EXPOSURE MWd	STATUS AS OF 6-30-67 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	NO OF CAPS & DESIGNATION	POWER GENERATION KW/FT MAX	POWER GENERATION KW/FT MIN	MID-PLANE BURNUP RATES % Mwd x 10^4 MAX	MID-PLANE BURNUP RATES MIN	STATUS AS OF 6-30-67 %BU(MAX)	MATERIAL CAPSULES: NO OF CAPS & DESIGNATION	MATERIAL	TYPE OF SAMPLE: BURST TEST	TENSILE	CREEP RUPTURE	STATUS AS OF 6-30-67 NVT x 10^{-22} TOTAL FLUX
XG19 CONT.	6D2	PNWL	7,500		826	1-13-67									8					0.2
															A26	304,316, 348		X		
															A27	304,316, 348		X		
															A28	304,316, 348		X		
															A29	304,316, 348		X		
															A32	304,316, 348		X		
															A33	304,316, 348		X		
															A34	304,316, 348		X		
															A35	304,316, 348		X		
		PNWL			826										1 BG5	Graphite				0.2
XG20	6BF	GE	7,500		826	1-13-67		UO_2-20PuO_2	9 F8H F8I F8J F8K F8L F8M F8N F8O F8P	8	7	3.60	3.10	0.3						
		UNC			826			$(U, Pu)C$	3 UNC84 UNC85 UNC86	20	19	4.24	3.92	0.3						
		PNWL			826										4					0.2
															A14	304,316, 348		X		
															A15	304,316, 348		X		

TABLE XXV (Cont.)

	Grid Location	Experimenter(s)	Goal Exposure MWd	Final Exposure MWd	Status as of 6-30-67 MWd	Date Installed	Date Removed	FUEL CAPSULES: Fuel	No. of Caps & Designation	Power Generation kW/ft Max	Power Generation kW/ft Min	Mid-Plane Burnup Rates MWd x 10^4 Max	Mid-Plane Burnup Rates Min	Status 6-30-67 BU Max	MATERIAL CAPSULES: No. of Caps & Designation	Material	Type of Sample: Burst Test	Type of Sample: Tensile	Type of Sample: Creep Rupture	Status as of 6-30-67 NVT x 10^{-22} Total Flux
X020 CONT.	6B5		7500			1-13-67									A30	304,316, 348		X		
															A31	304,316, 348		X		
		PNWL													1 B_{Go}	Graphice				0.2
		ANL													2 AS59	304 Vi-Ti	X	X		0.2
															AS60	Hast-X, Vi-Ti	X	X		
X021	2D1	PNWL	21,500		826	2-25-67									7 BNWL-7-2	304,316,321	X	X		0.4
															7-3	348, INC-X	X	X		
															7-4	INC-600, INC-800,	X	X		
															7-5	INC-718	X	X		
															7-6	INC-625	X	X		
															7-7	HAST-X	X	X		
															7-8		X	X		
X022	7C4	PNWL	8,000		826	2-26-67									7 BNWL-7-9	304,316,321	X	X		0.2
															7-10	348, INC-X	X	X		
															7-11	INC-600	X	X		
															7-12	INC-800	X	X		
															7-13	INC-718	X	X		
																HAST-X	X	X		
															7-14	INC-625				
															7-15		X	X		



<u>CUMULATIVE CRITICAL TIME AND GENERATOR ON TIME</u>

FIGURE 1

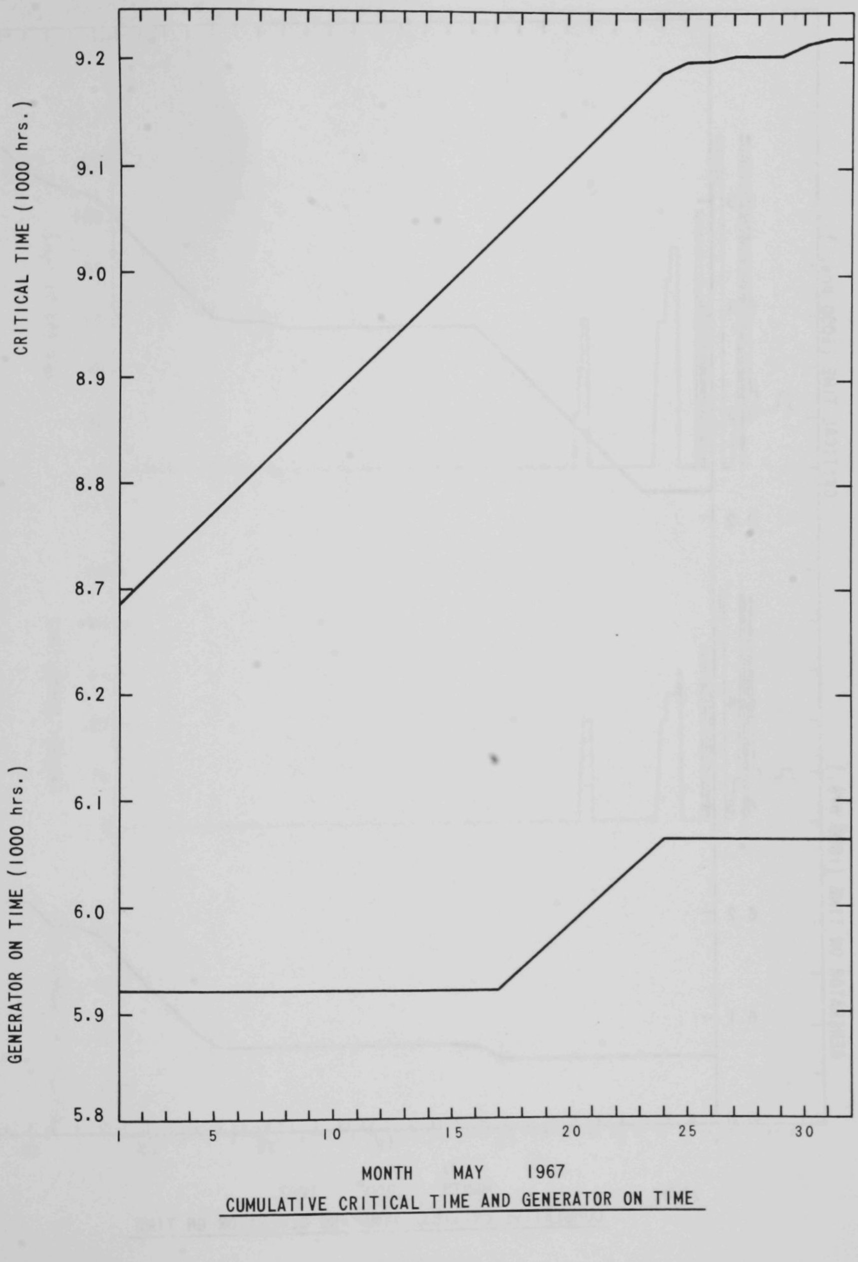
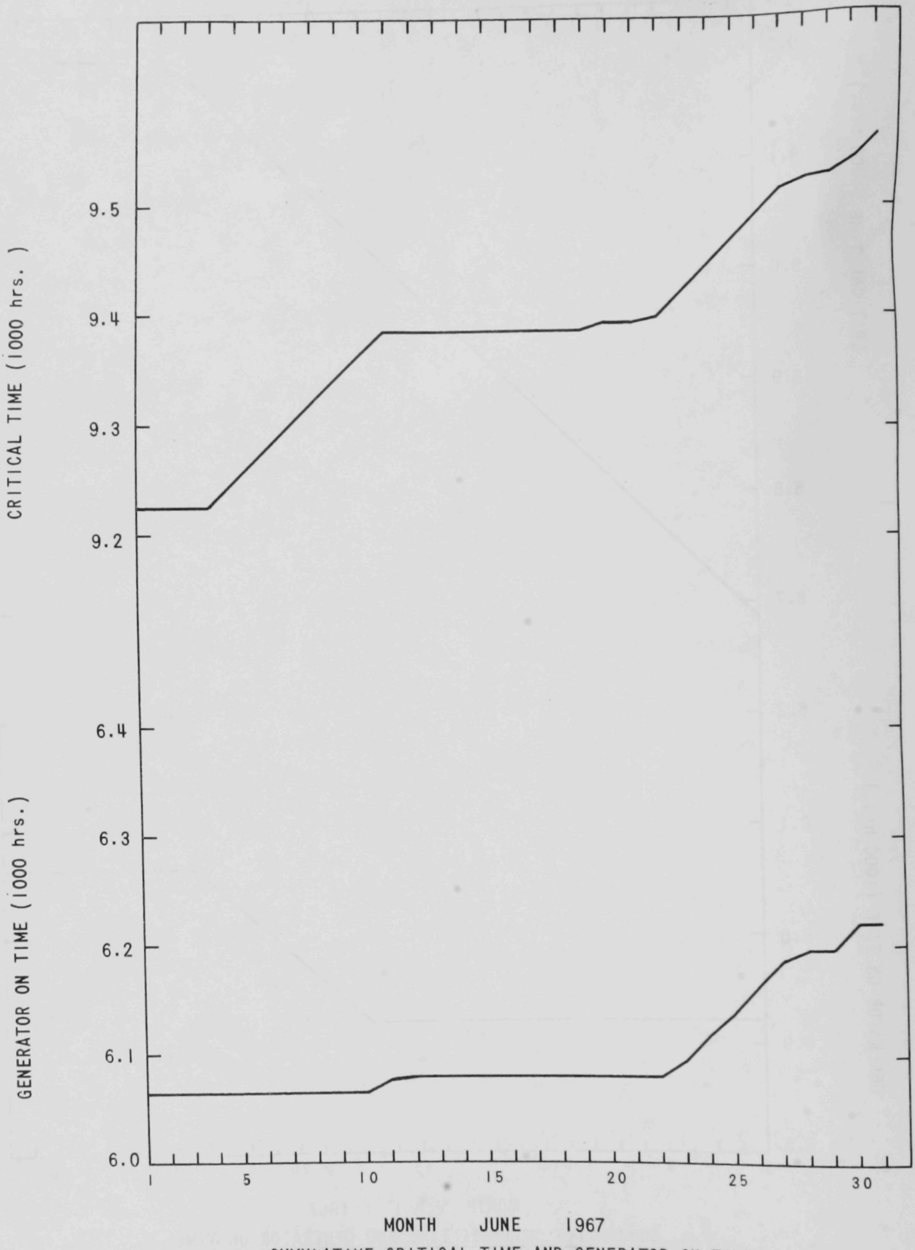
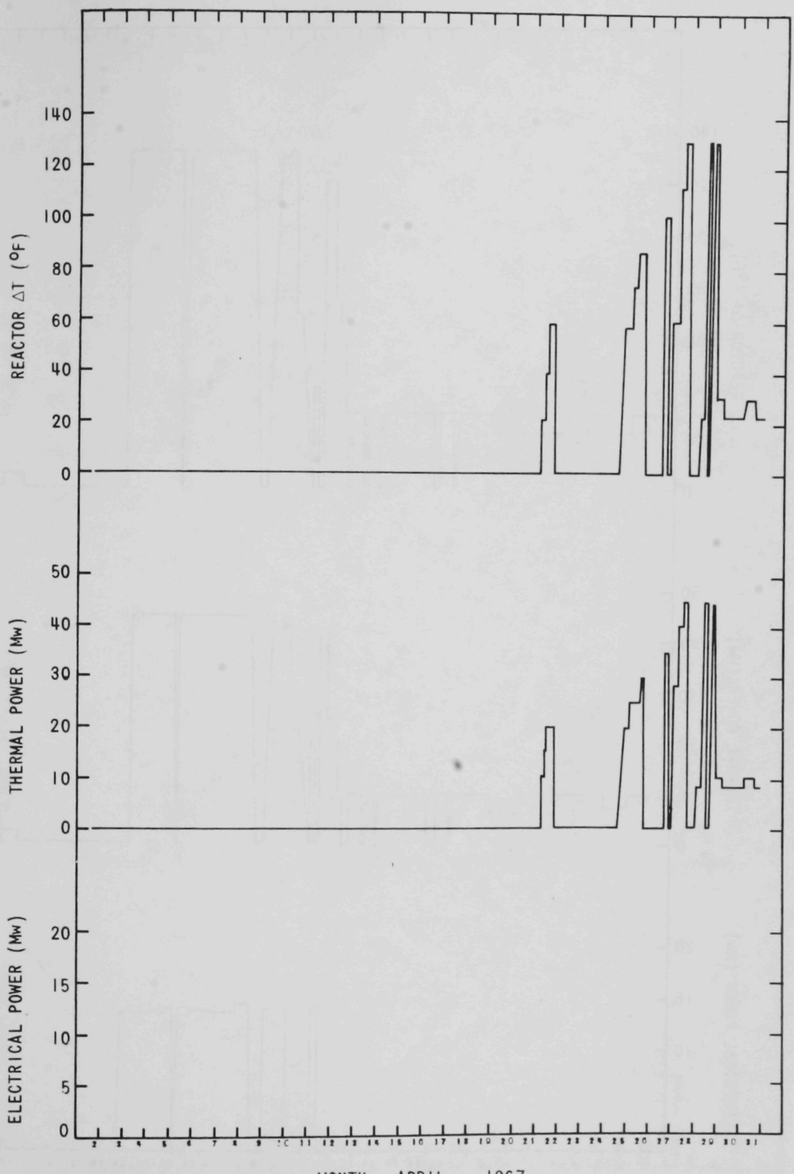

CRITICAL TIME (1000 hrs.)
GENERATOR ON TIME (1000 hrs.)
9.2
9.1
9.0
8.9
8.8
8.7
6.2
6.1
6.0
5.9
5.8
1
5
10
15
20
25
30
MONTH MAY 1967
CUMULATIVE CRITICAL TIME AND GENERATOR ON TIME

FIGURE 2



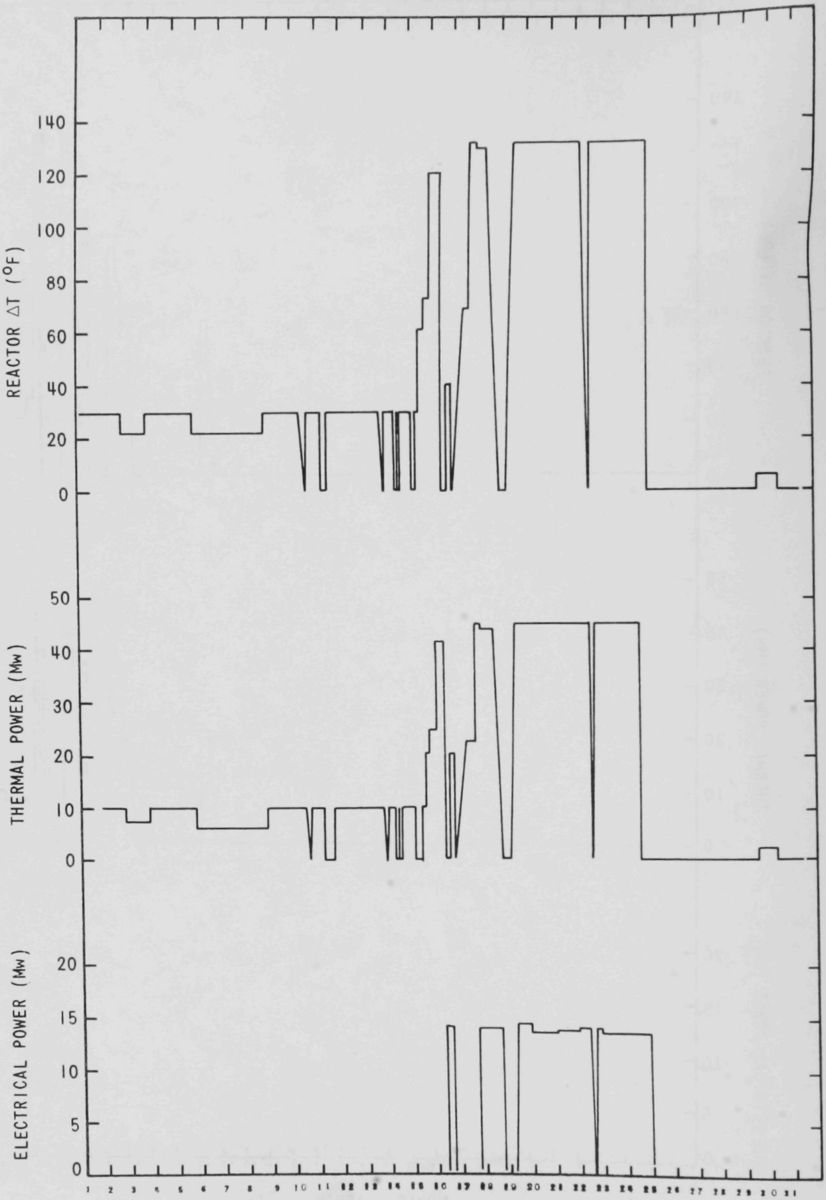
CUMULATIVE CRITICAL TIME AND GENERATOR ON TIME

FIGURE 5



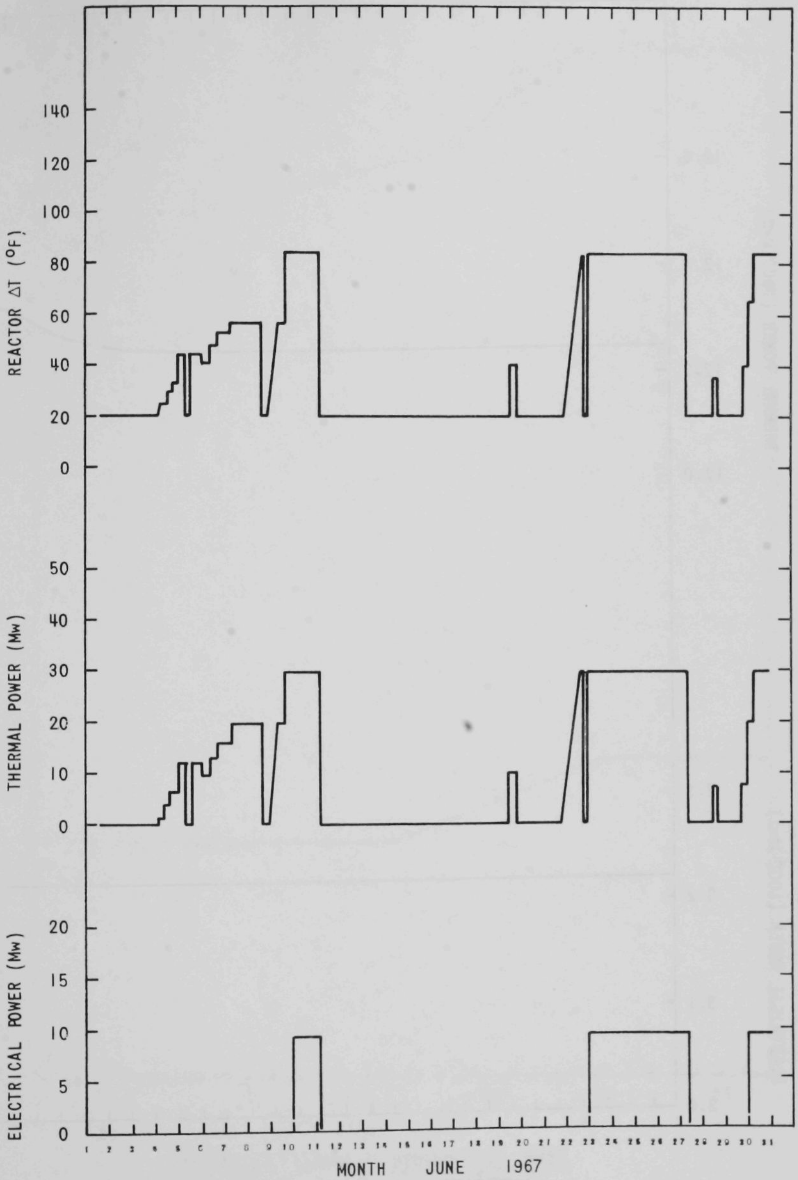
REACTOR ΔT, THERMAL POWER. AND ELECTRICAL POWER

FIGURE 4



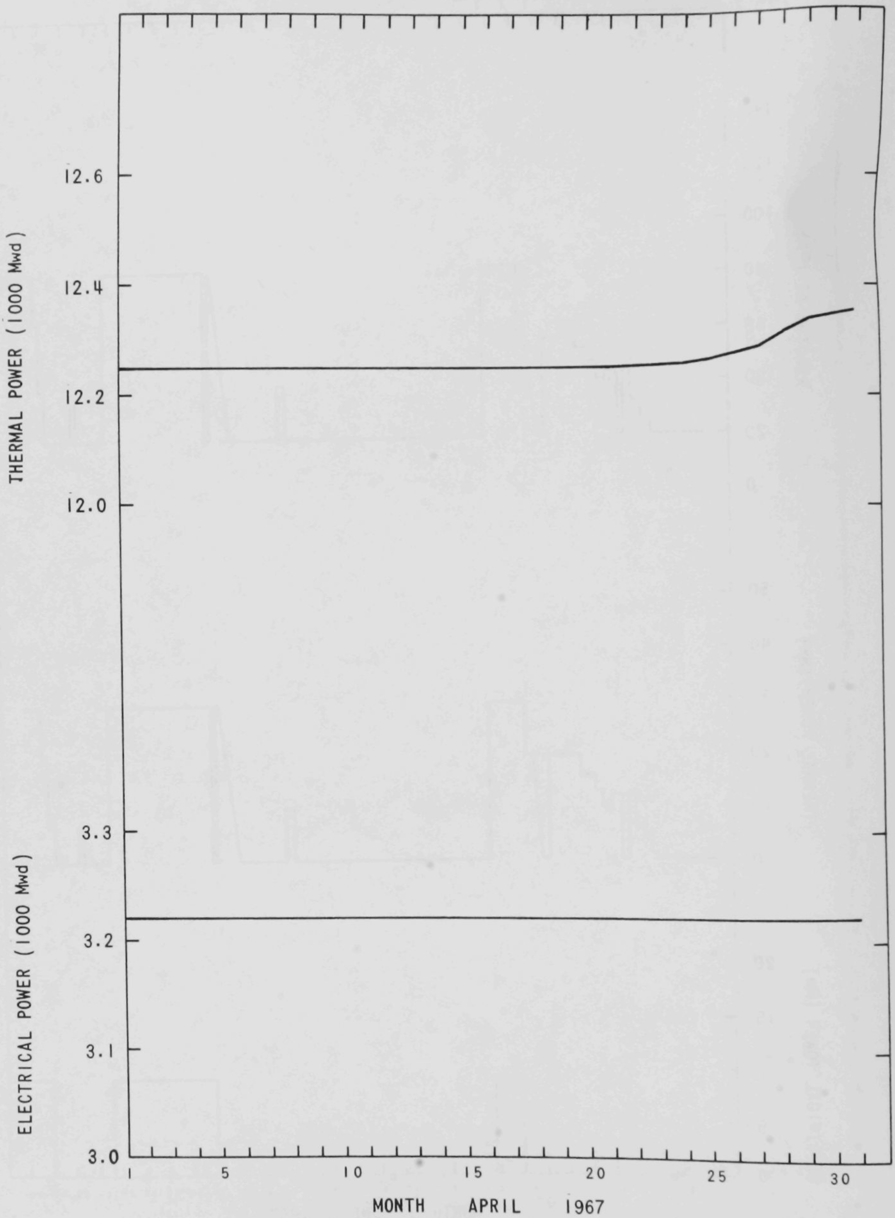
REACTOR ΔT, THERMAL POWER, AND ELECTRICAL POWER

FIGURE 5



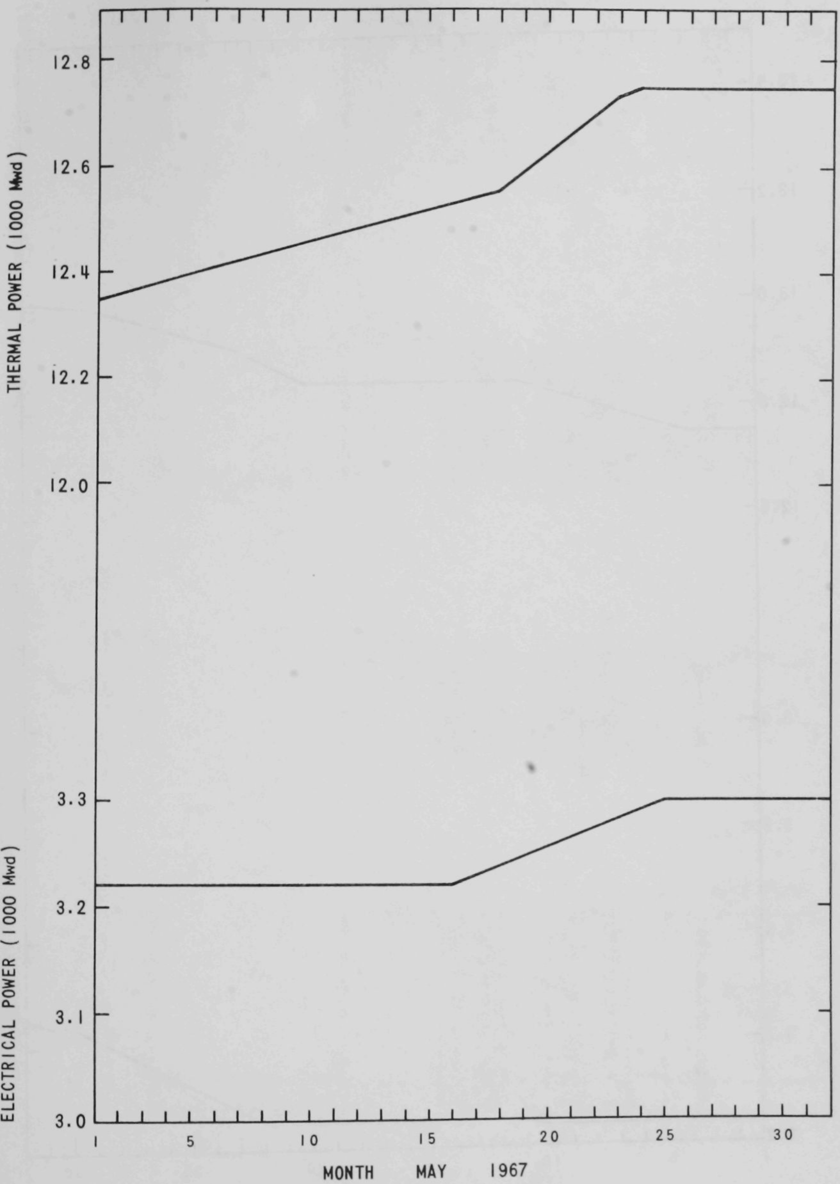
REACTOR ΔT, THERMAL POWER, AND ELECTRICAL POWER

FIGURE 6



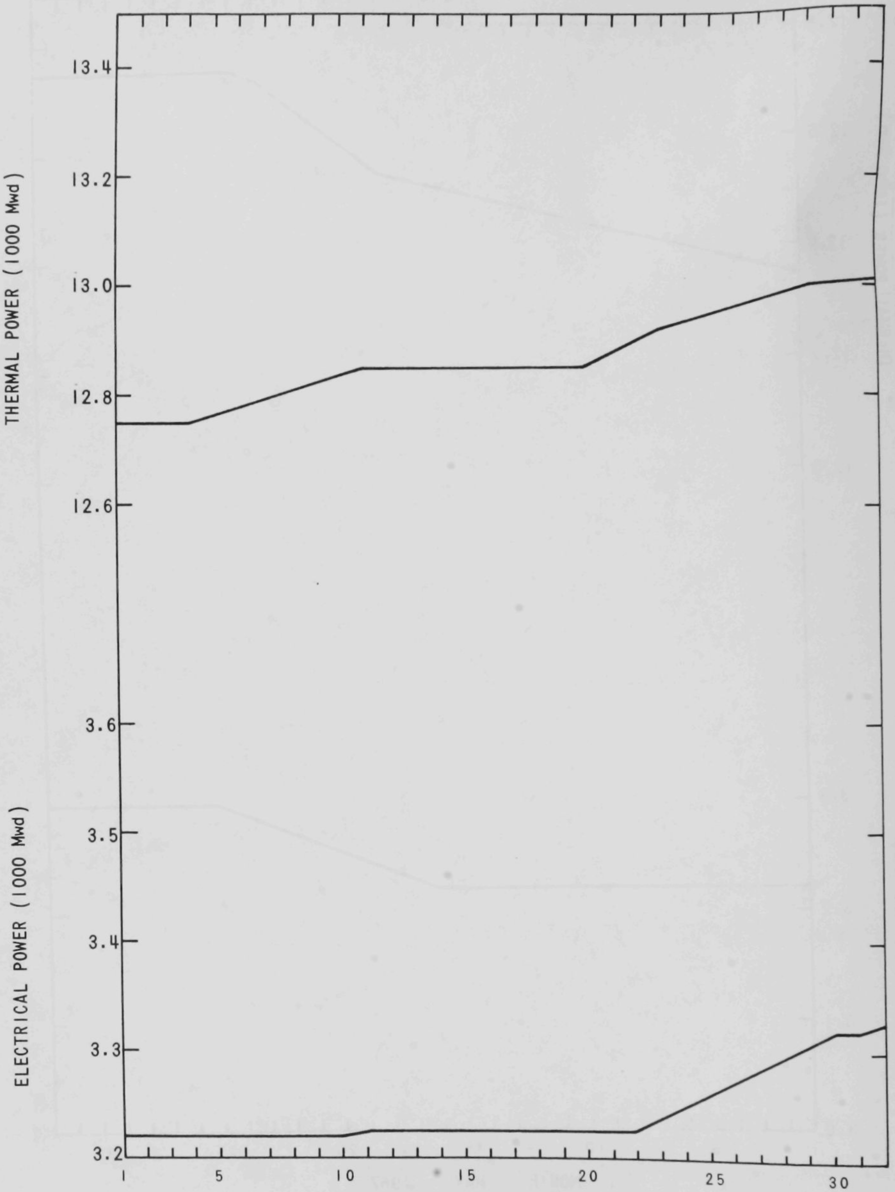
INTEGRATED THERMAL AND ELECTRICAL POWER

FIGURE 7



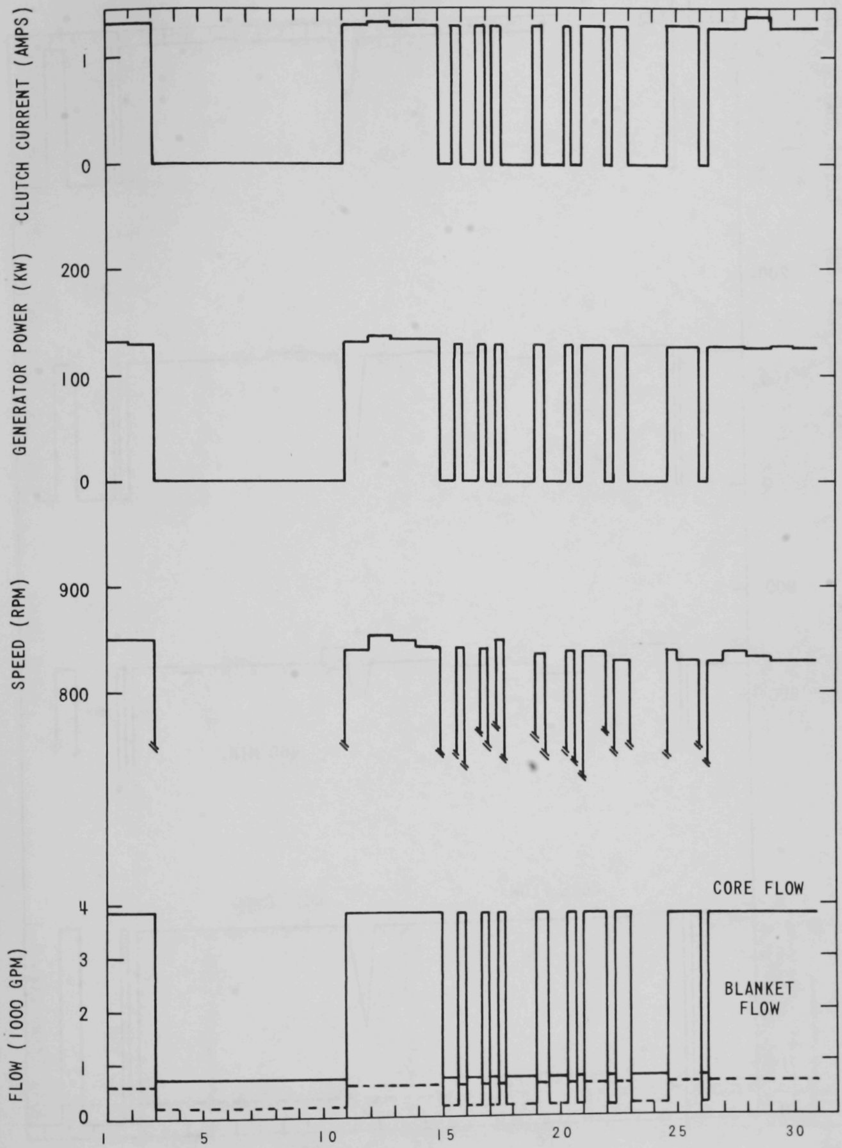
INTEGRATED THERMAL AND ELECTRICAL POWER

FIGURE 8



INTEGRATED THERMAL AND ELECTRICAL POWER

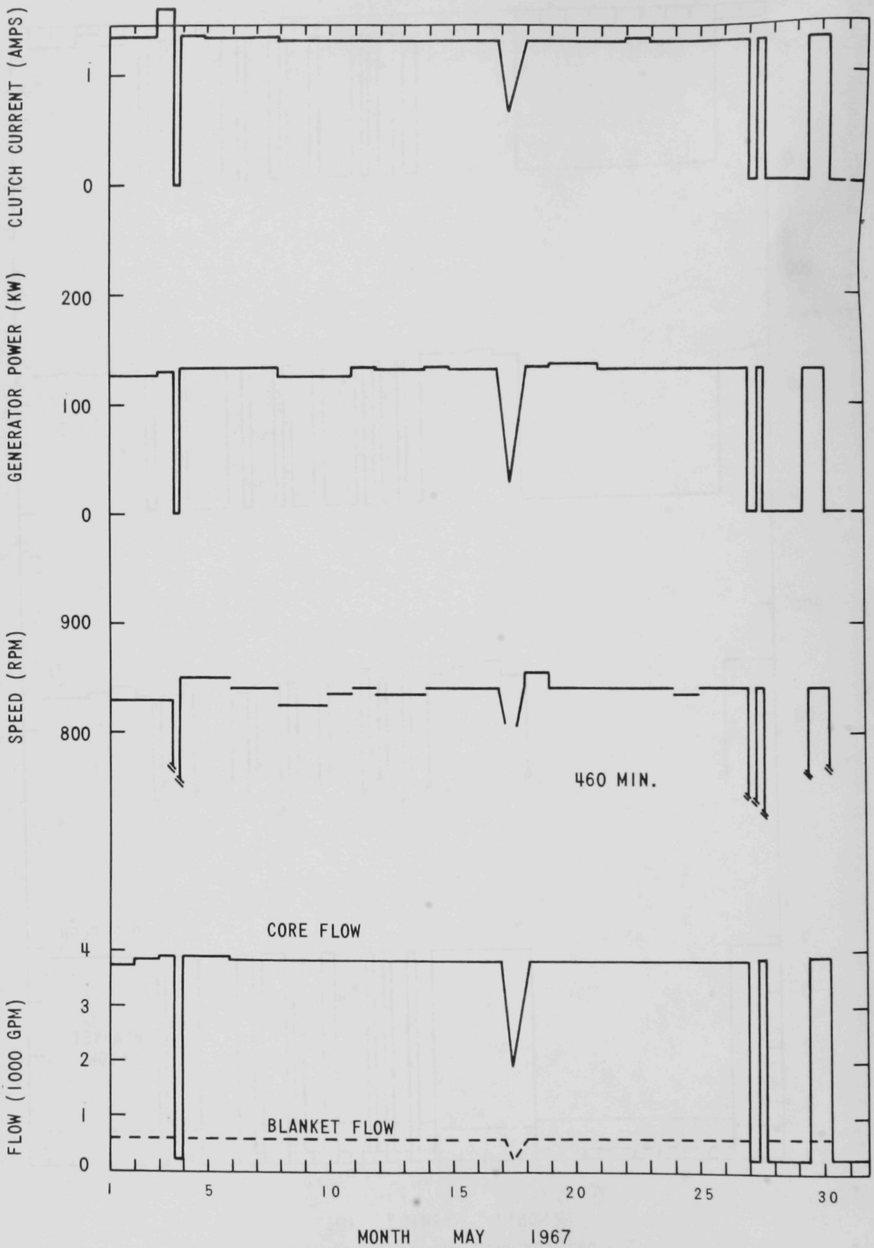
FIGURE 9



MONTH APRIL 1967

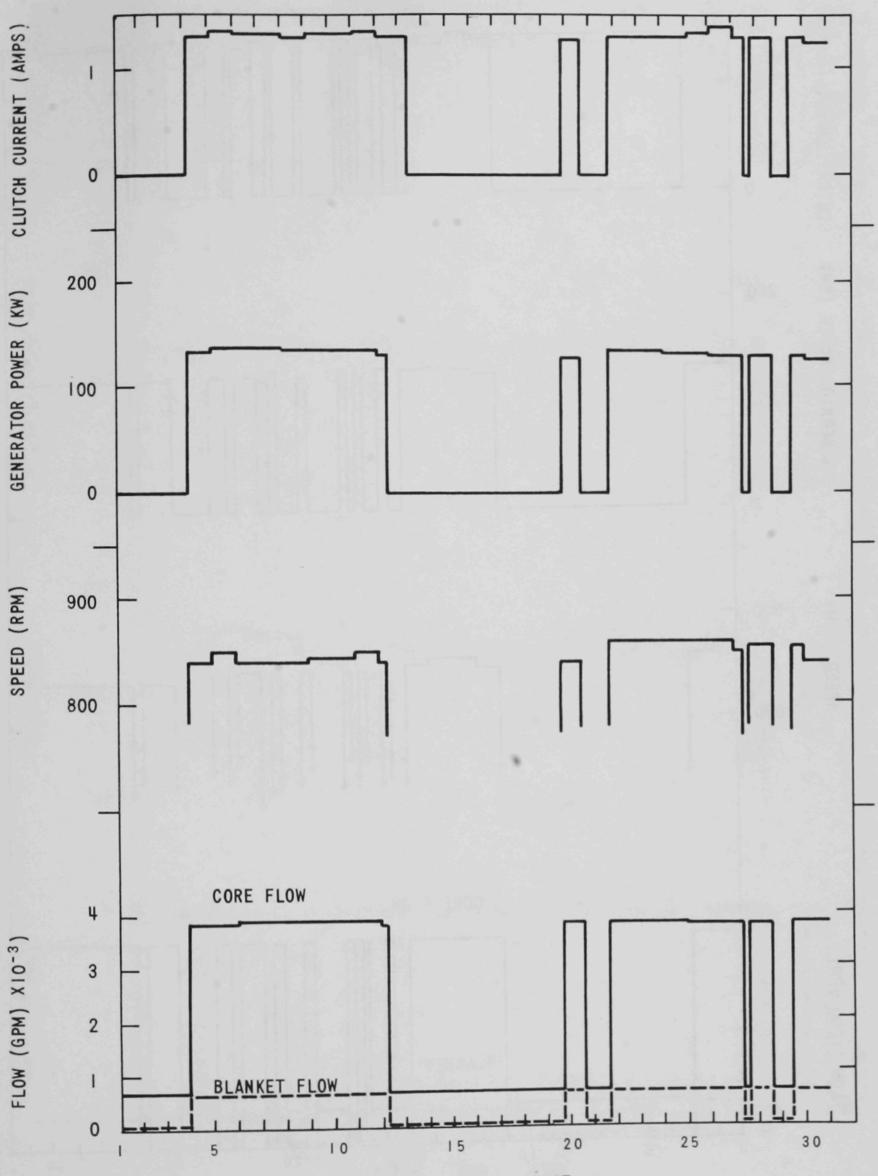
PRIMARY PUMP NO. 1 PERFORMANCE

FIGURE 10



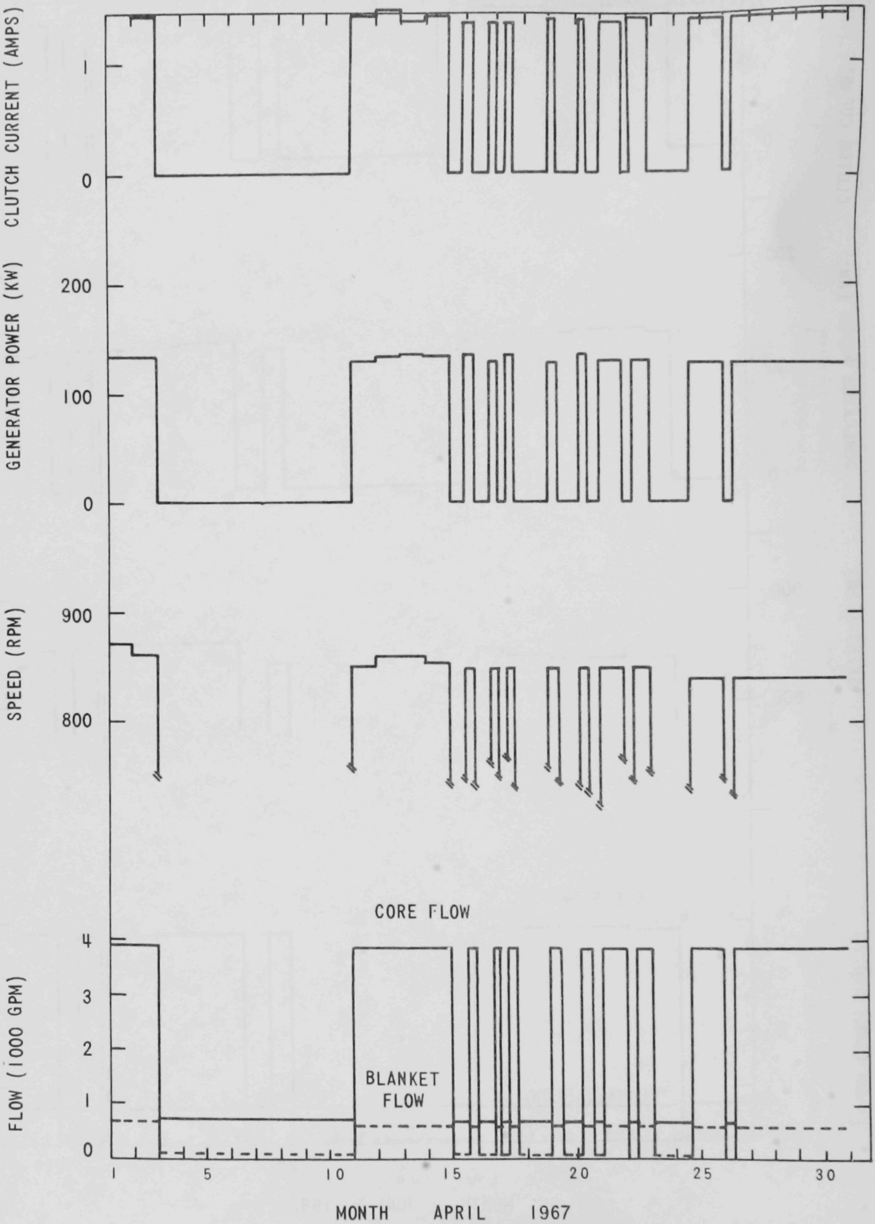
PRIMARY PUMP NO. 1 PERFORMANCE

FIGURE 11



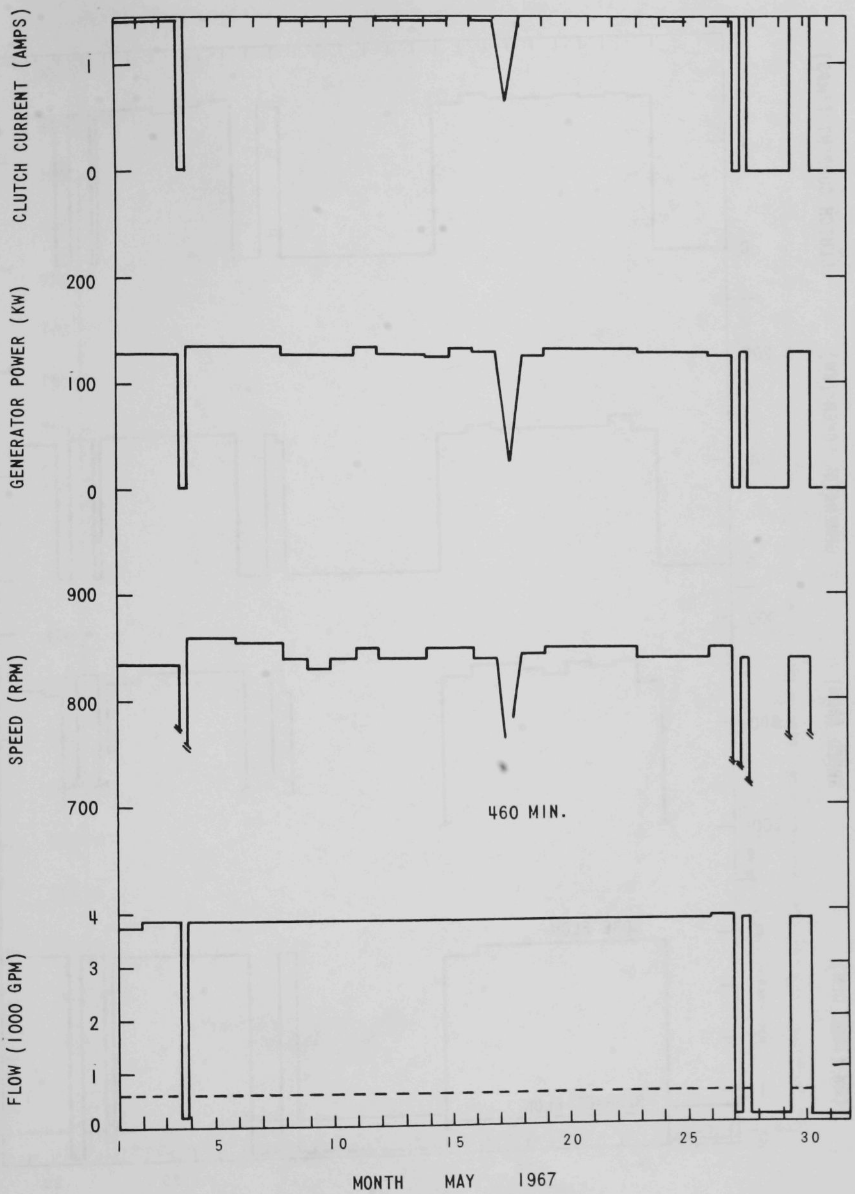
PRIMARY PUMP NO. 1 PERFORMANCE

FIGURE 12



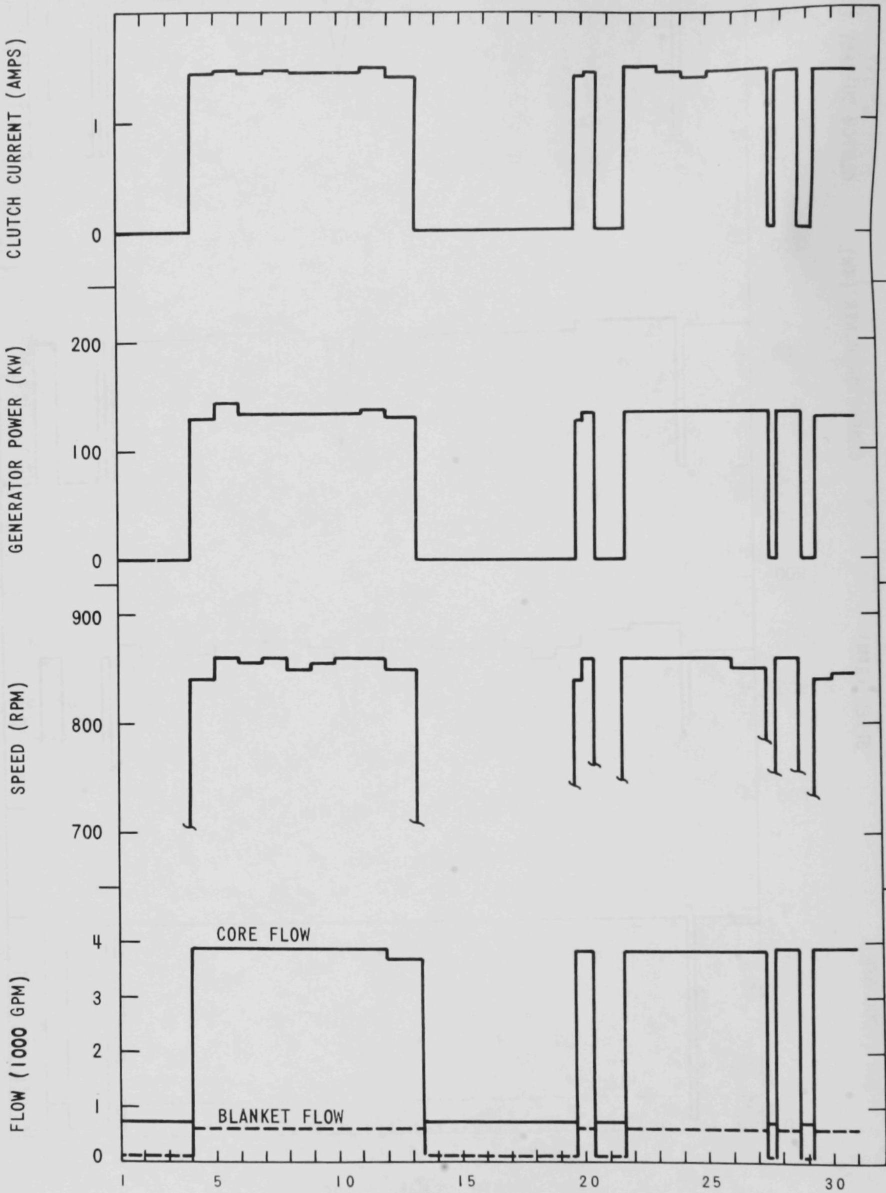
PRIMARY PUMP NO. 2 PERFORMANCE

FIGURE 13



PRIMARY PUMP NO. 2 PERFORMANCE

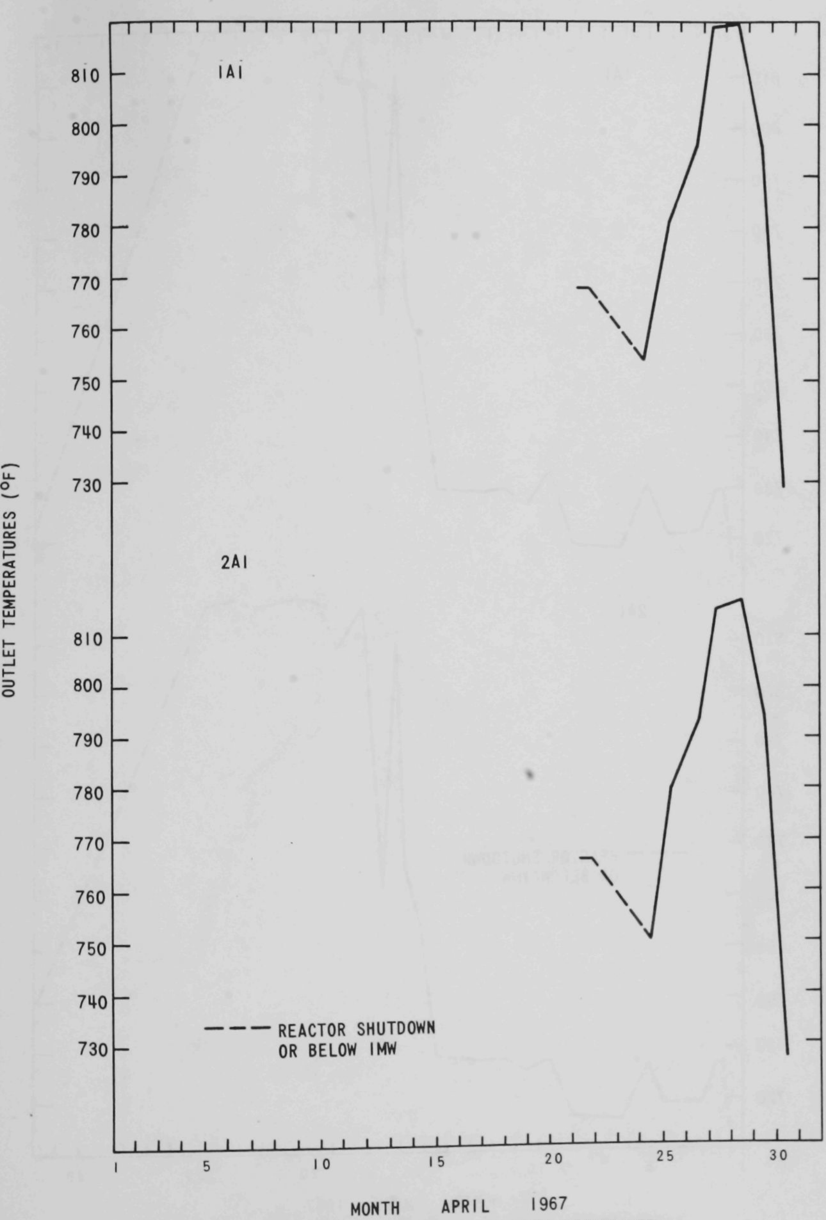
FIGURE 14



MONTH JUNE 1967

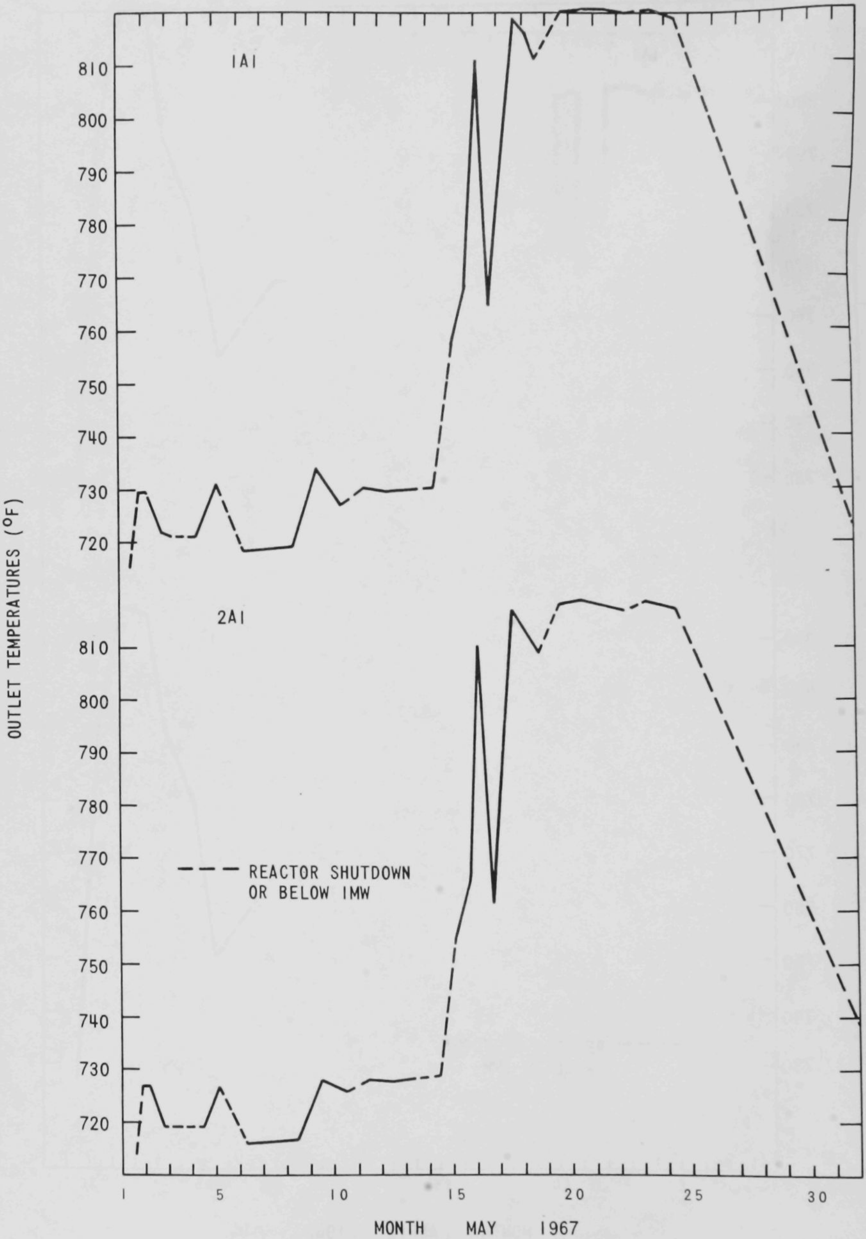
PRIMARY PUMP NO. 2 PERFORMANCE

FIGURE 15



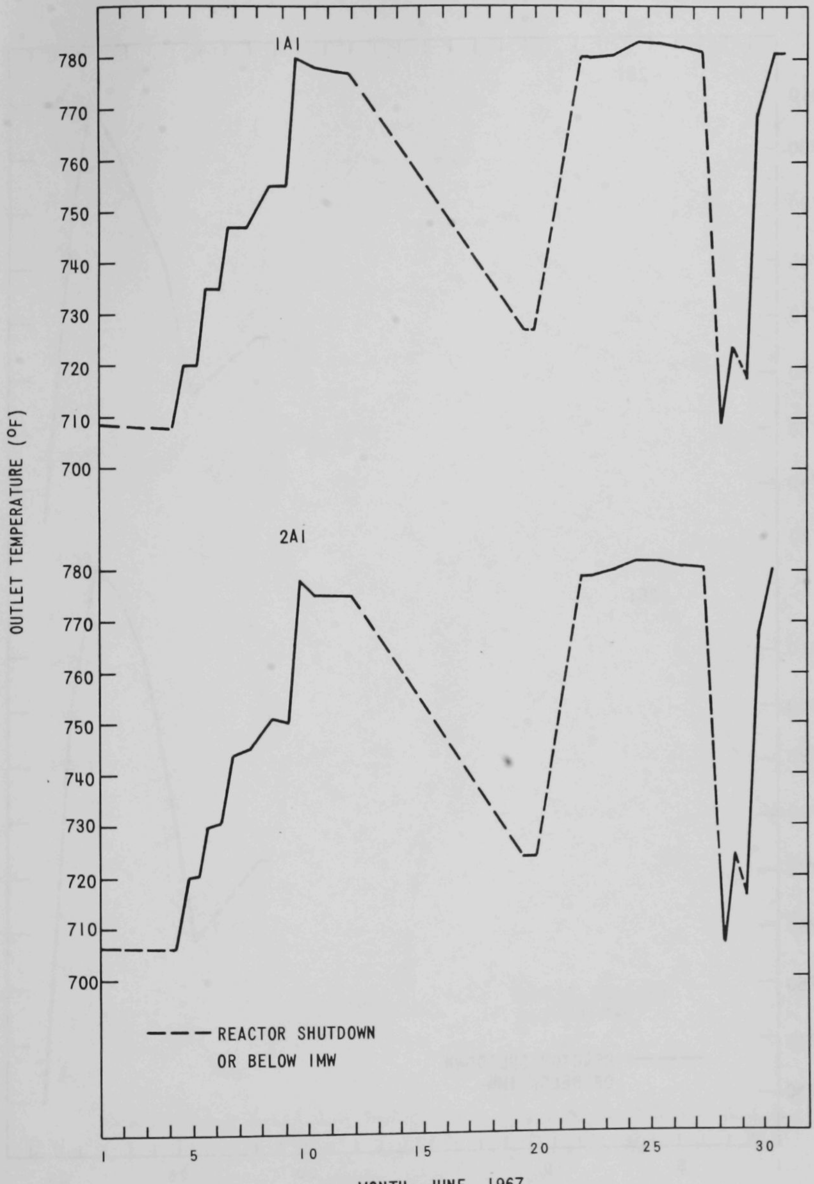
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 16



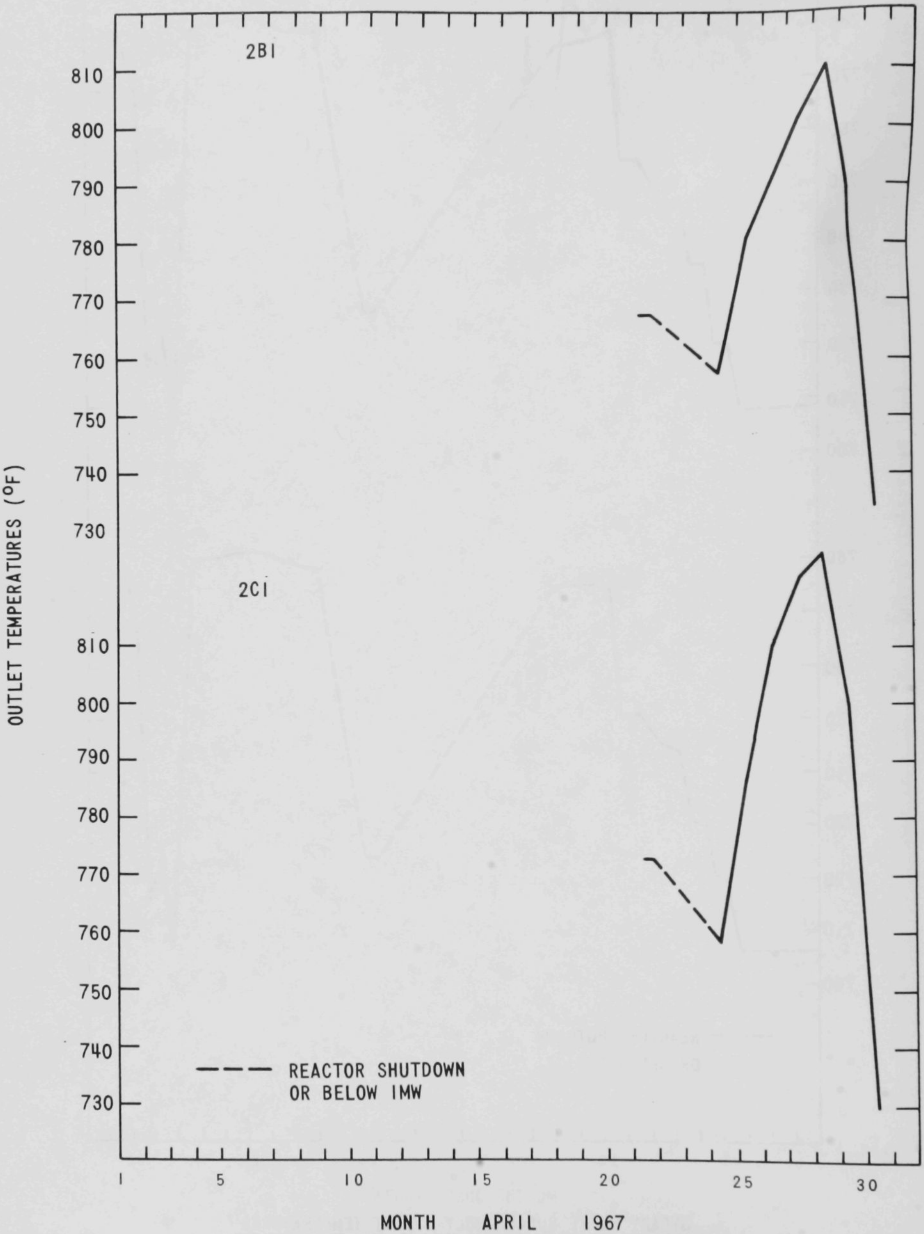
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 17



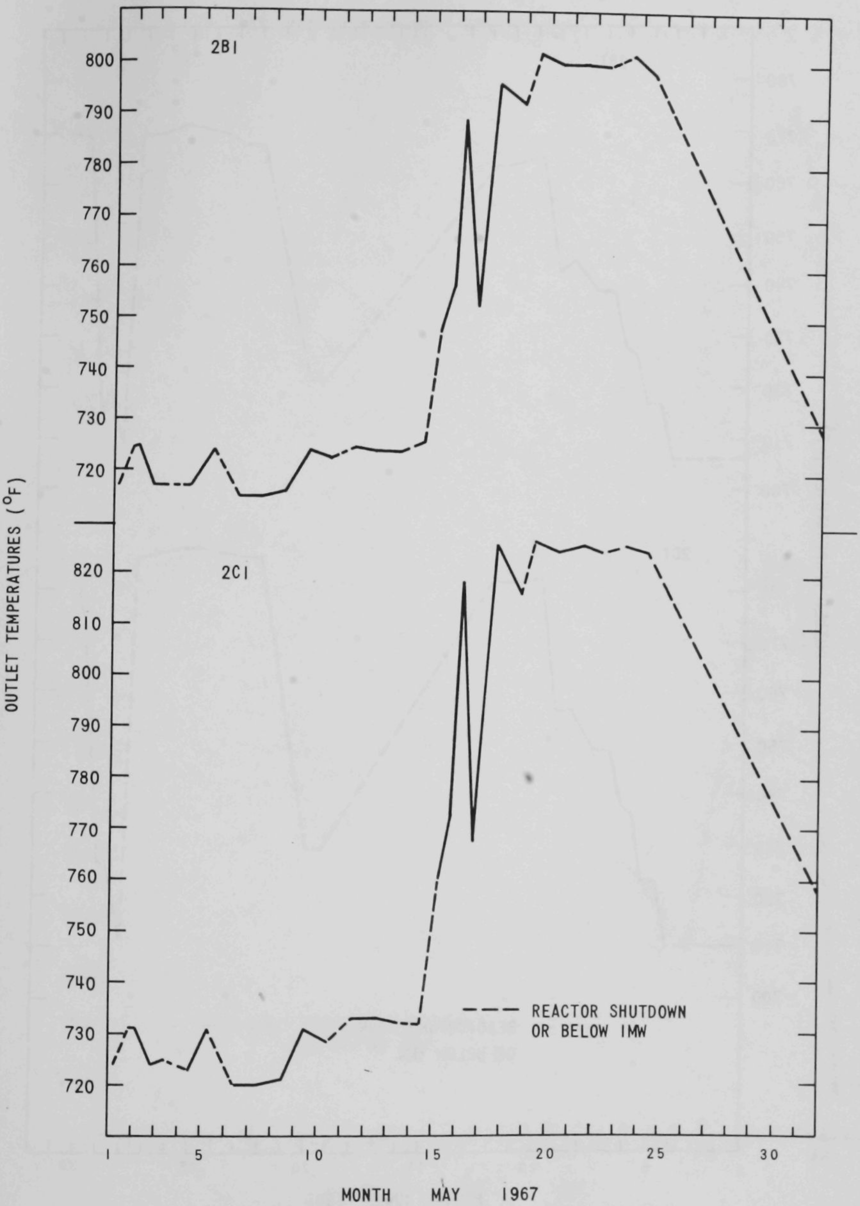
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 18



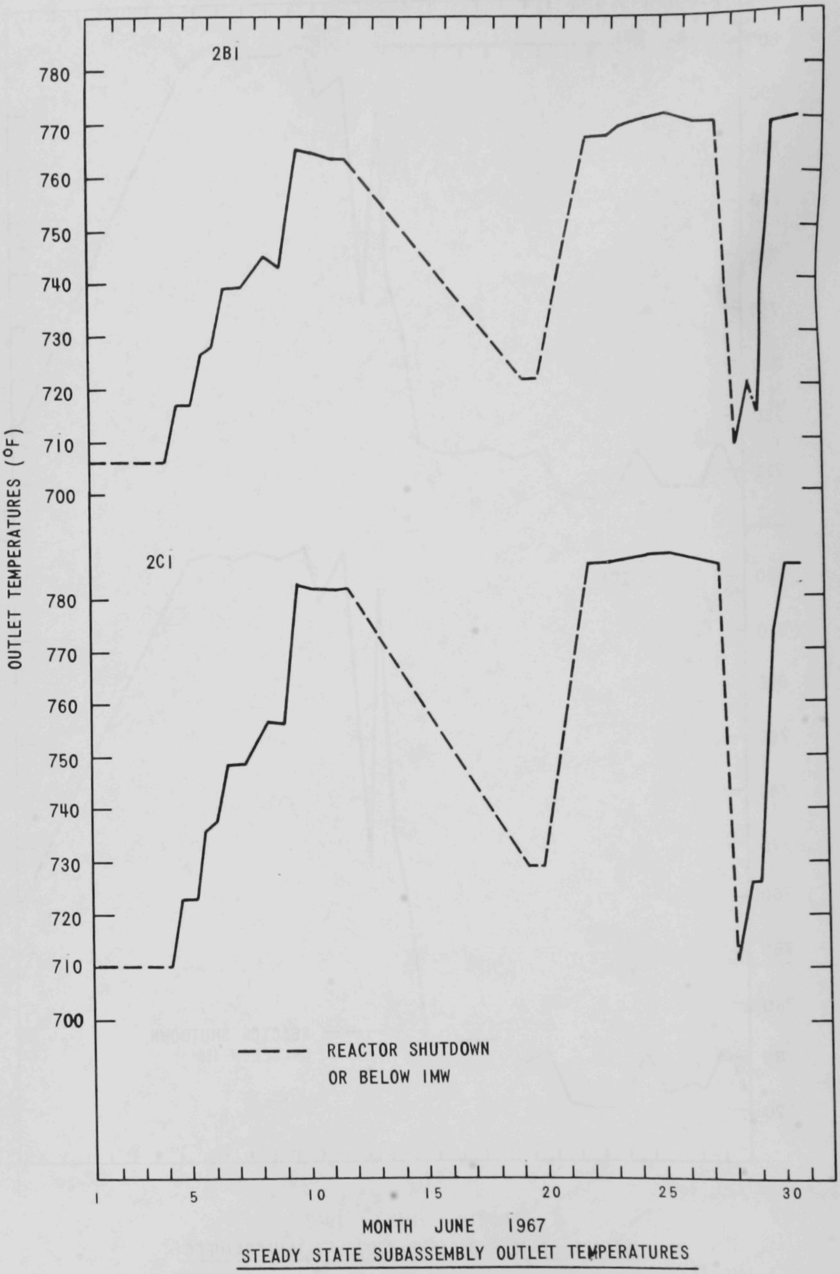
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 19



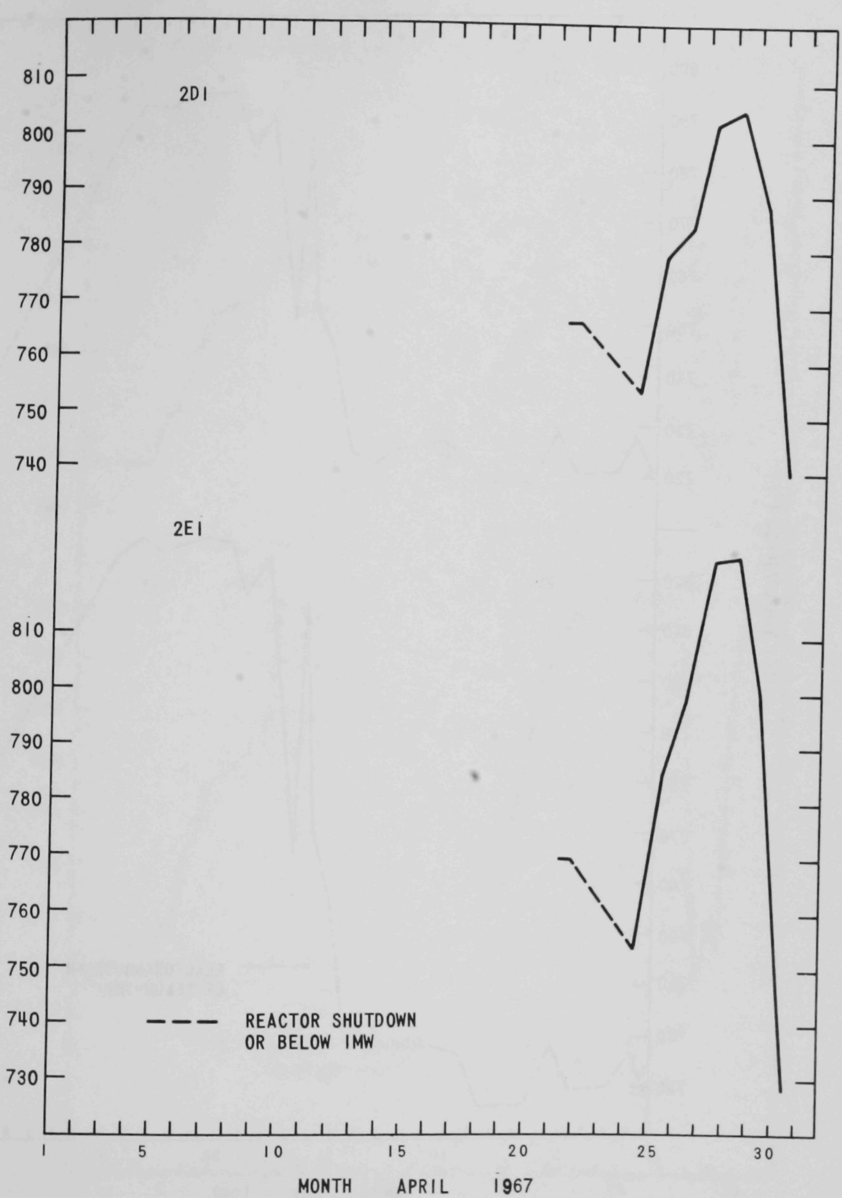
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 20



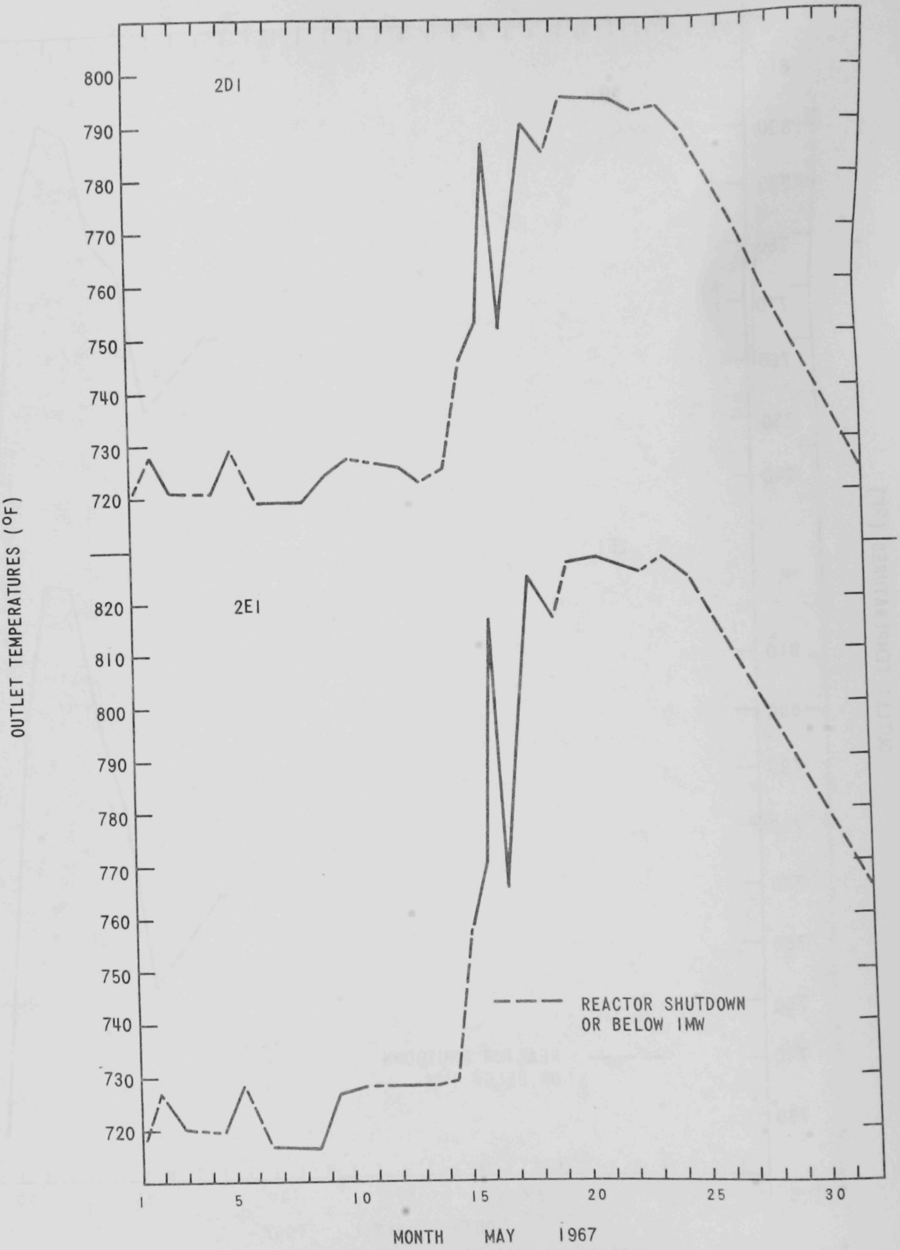
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 21



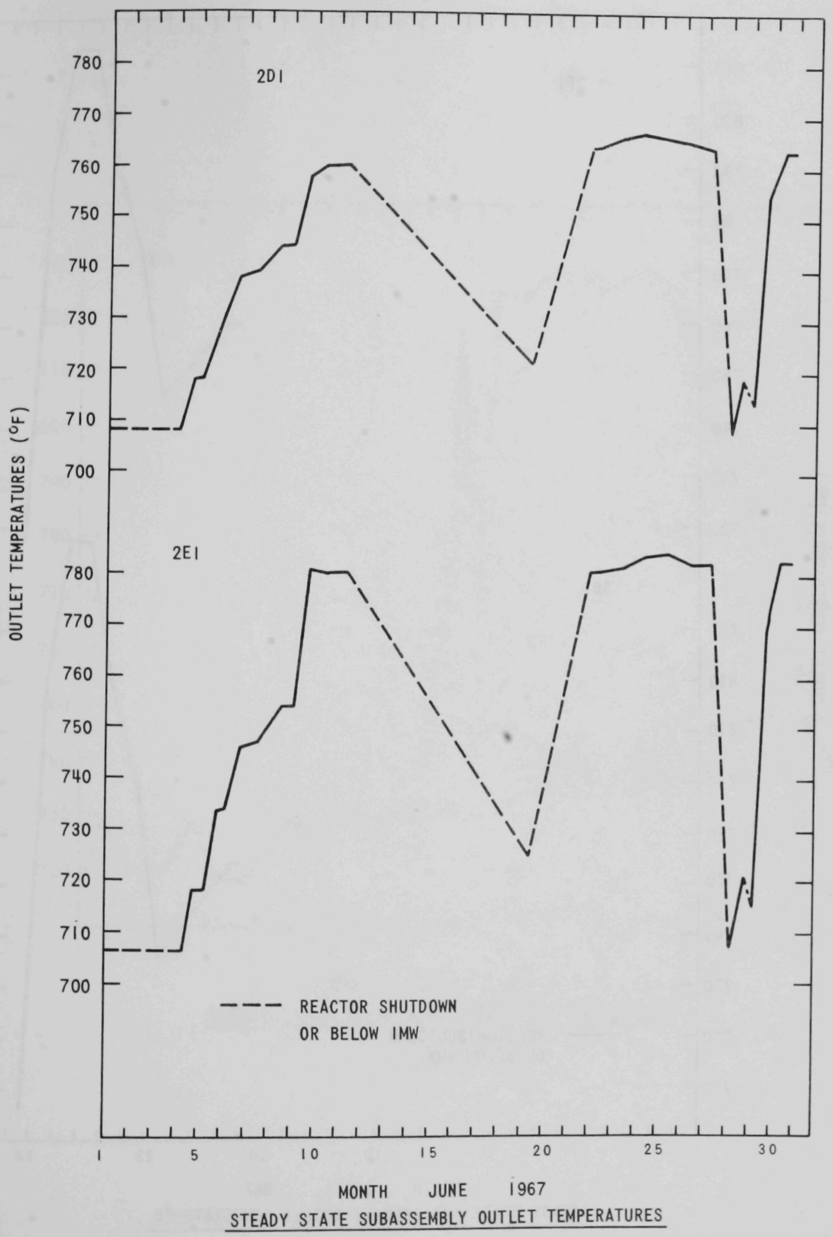
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 22



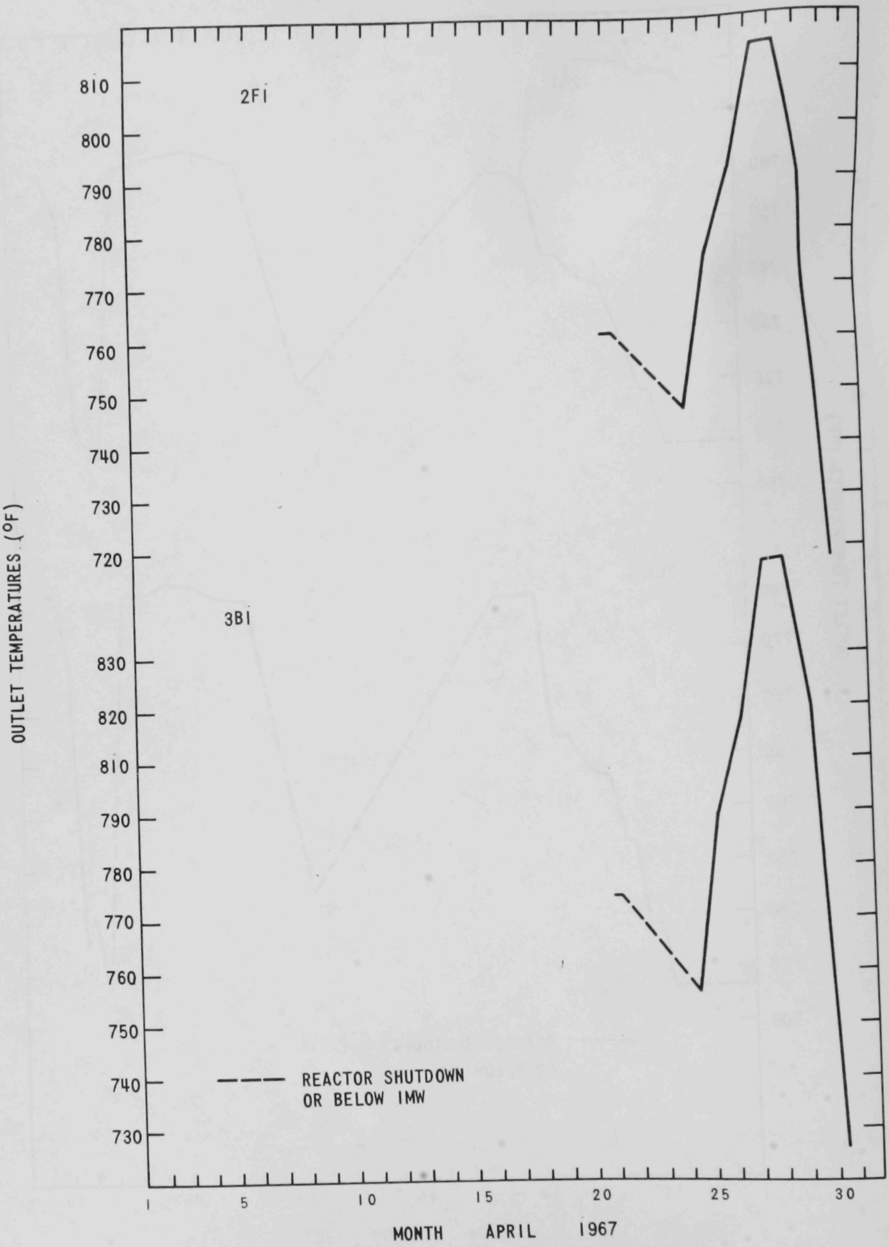
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 23



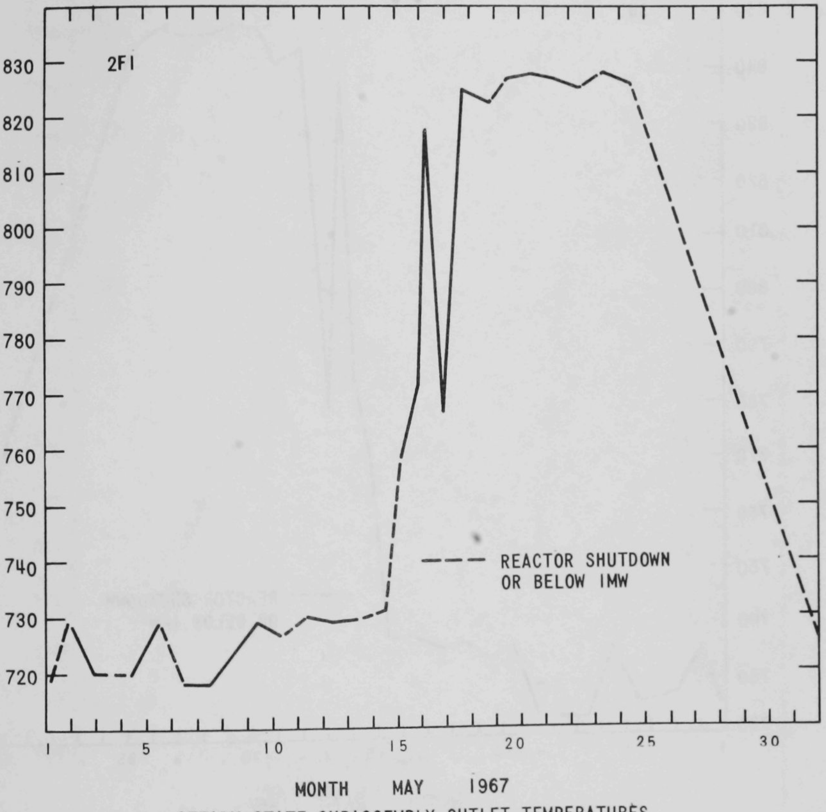
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 24



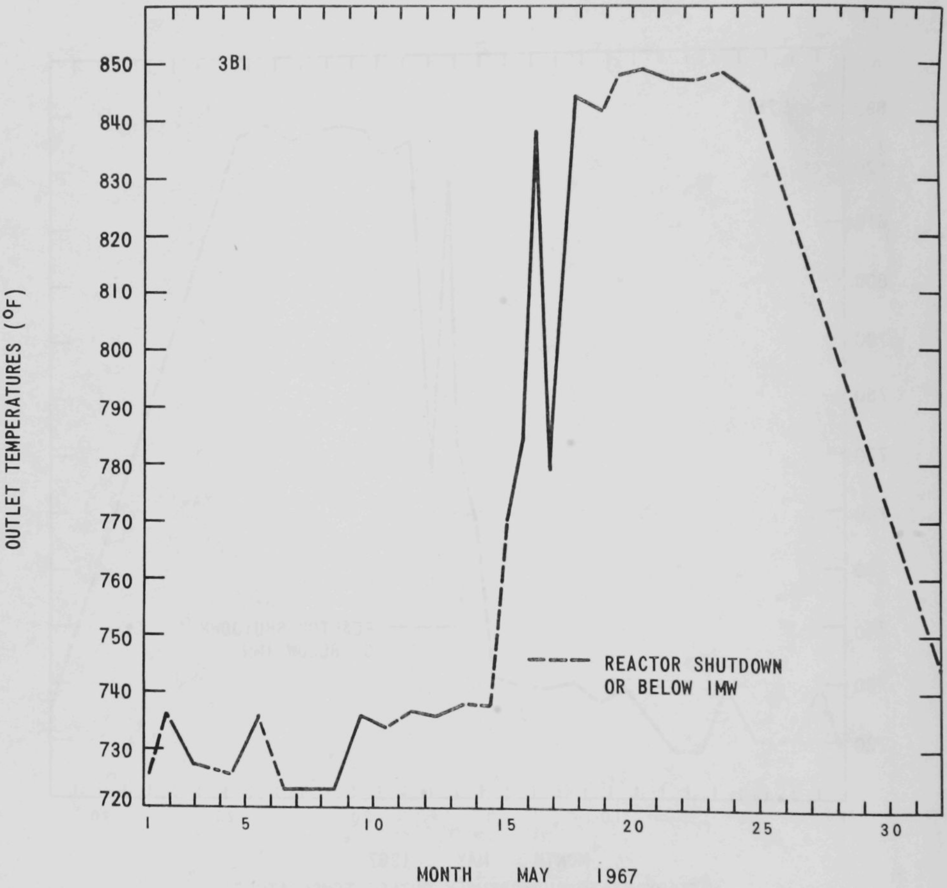
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 25



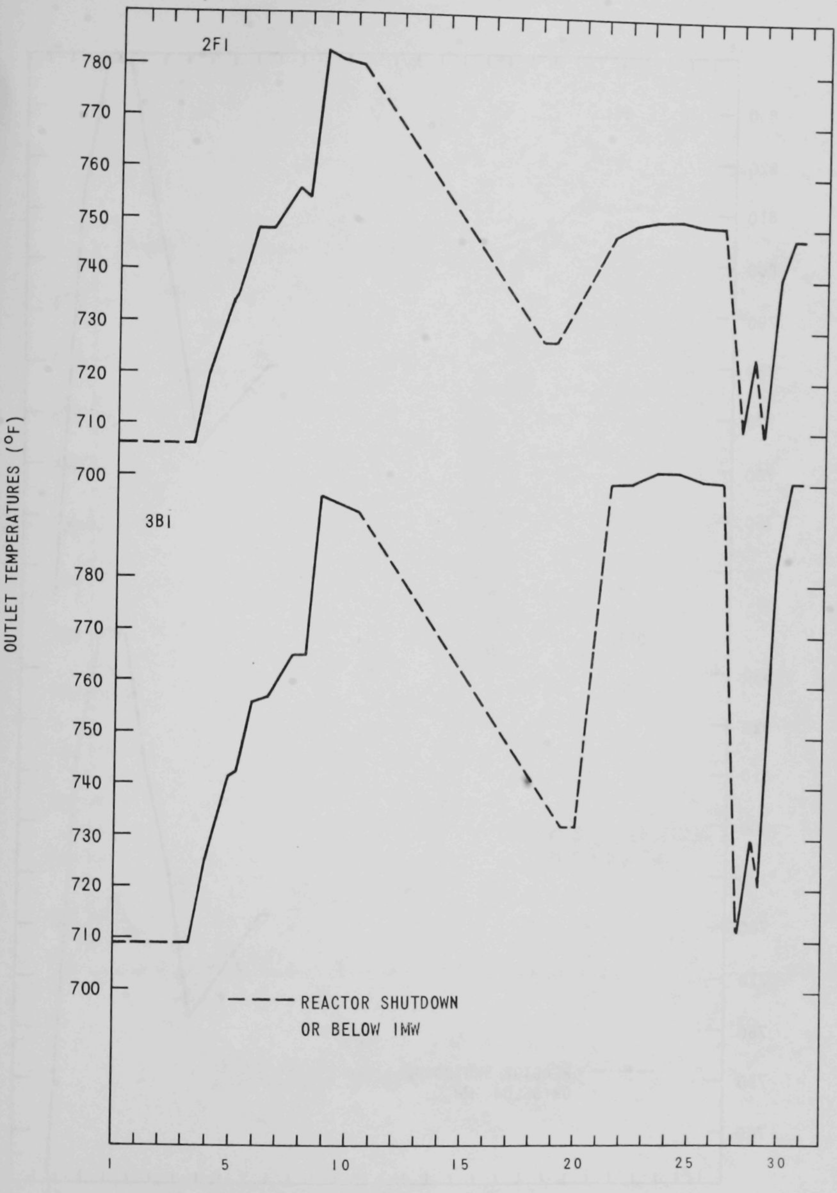
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 26



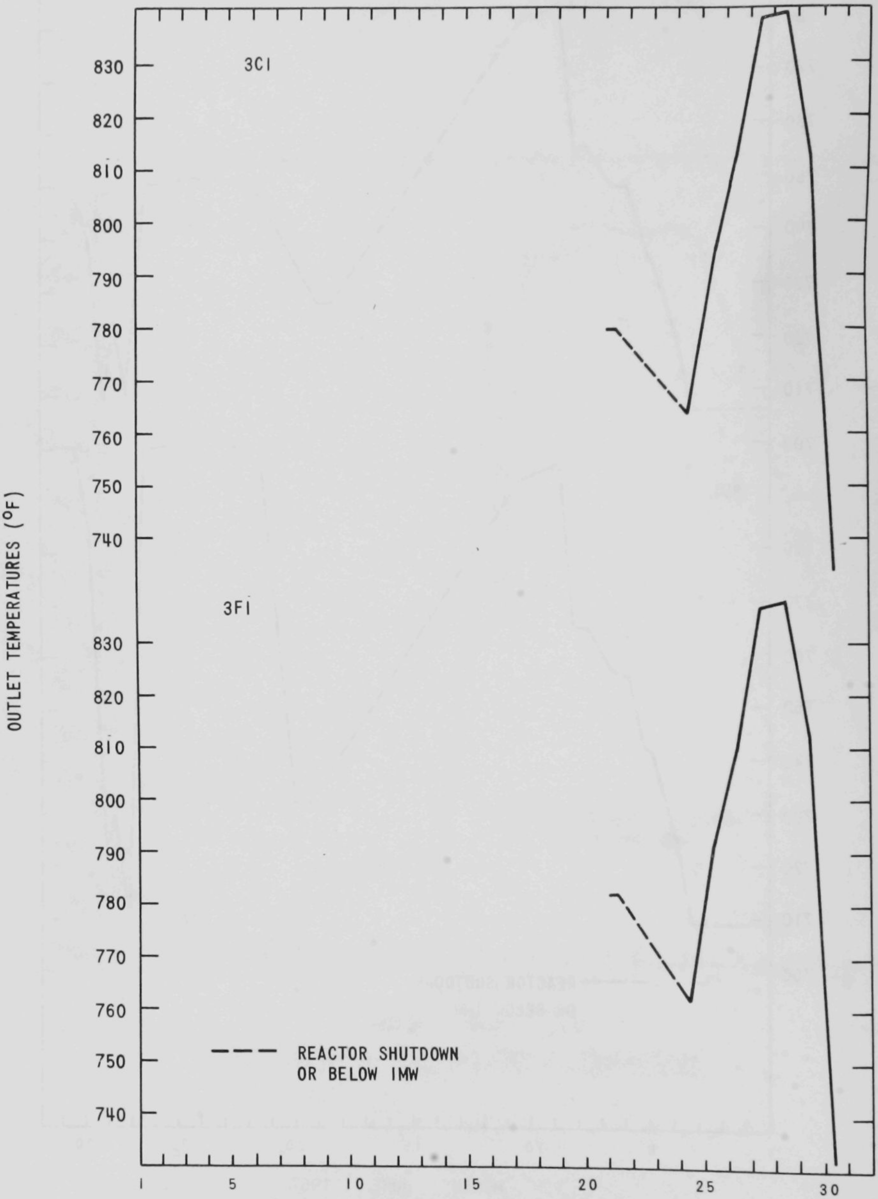
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 27



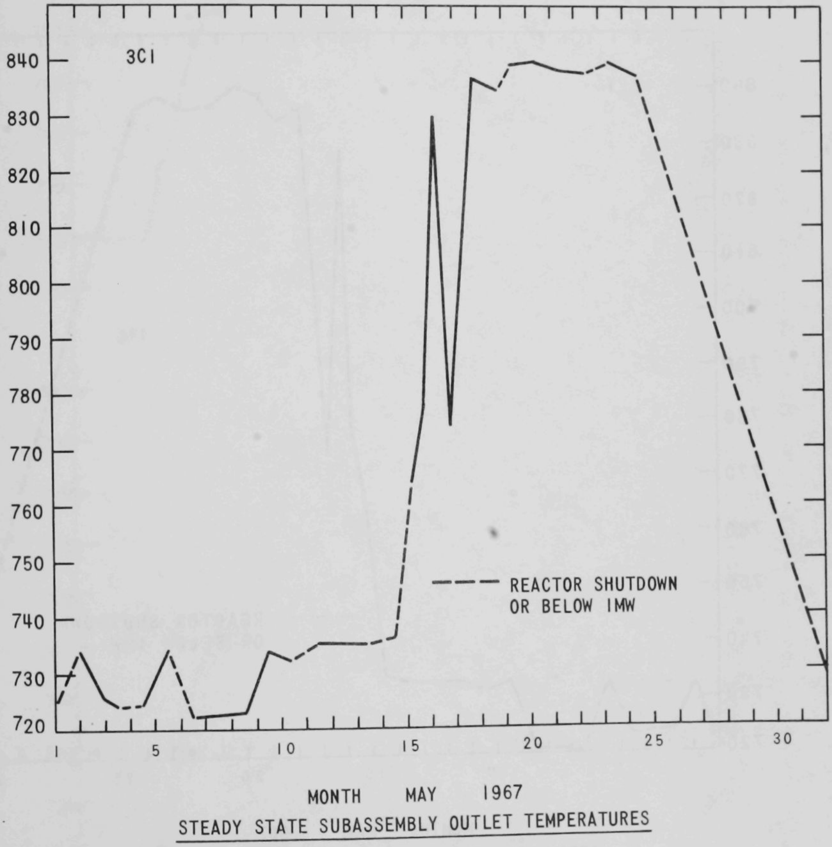
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 28



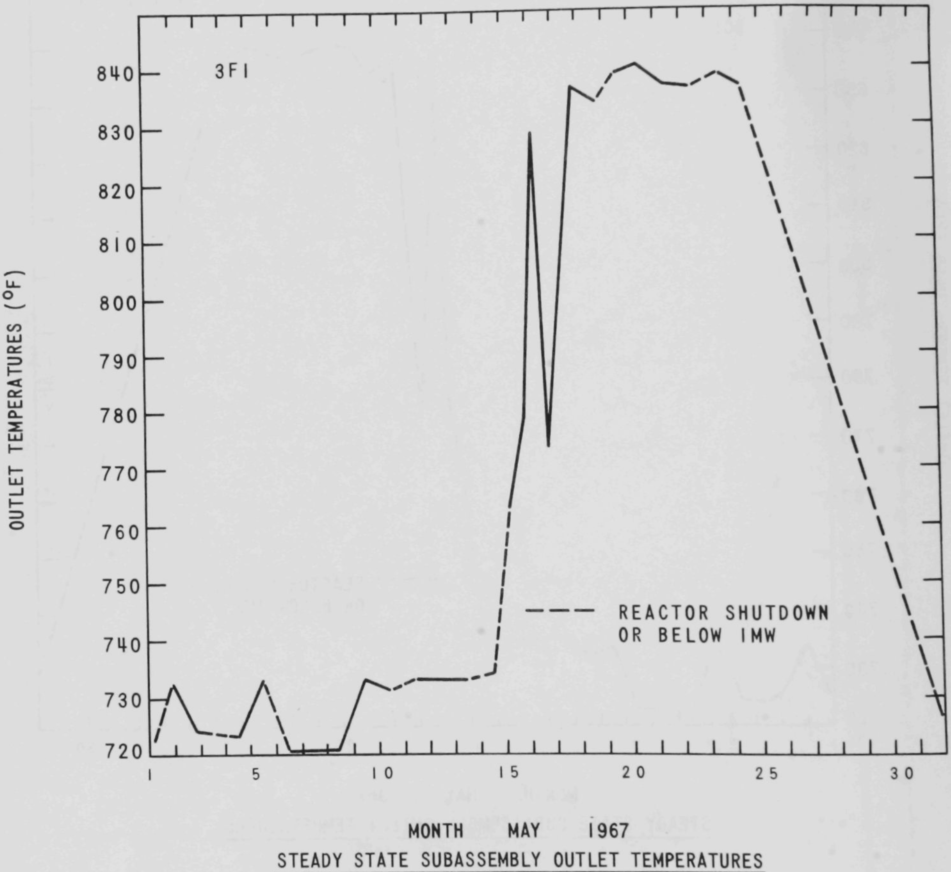
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 29



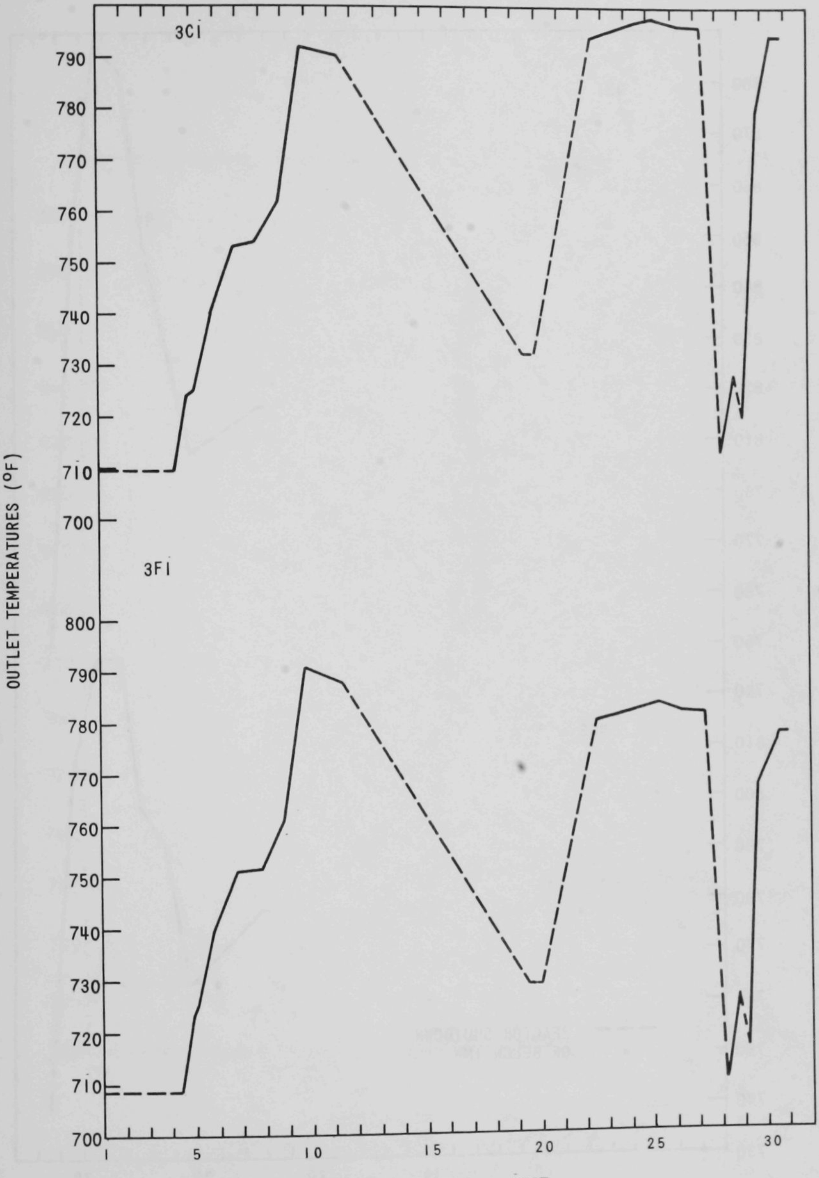
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 30



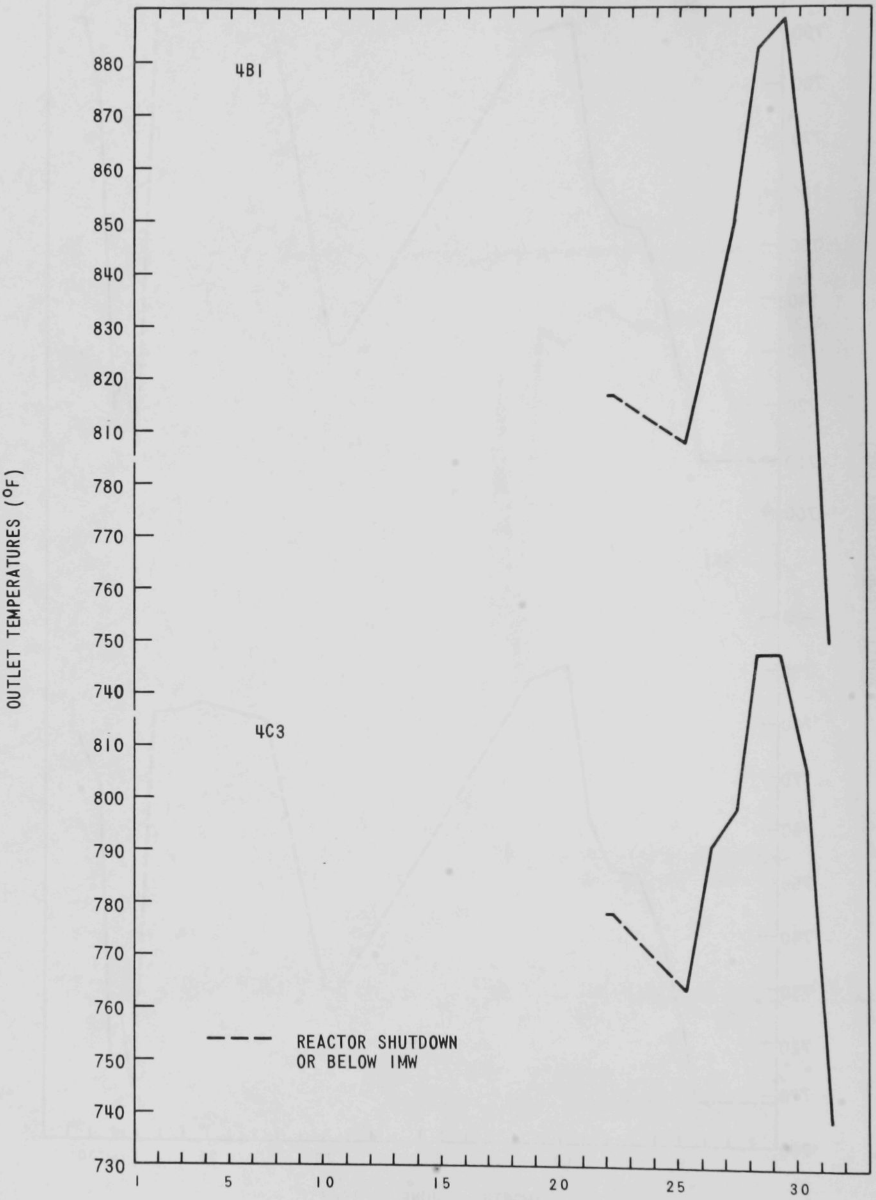
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 31



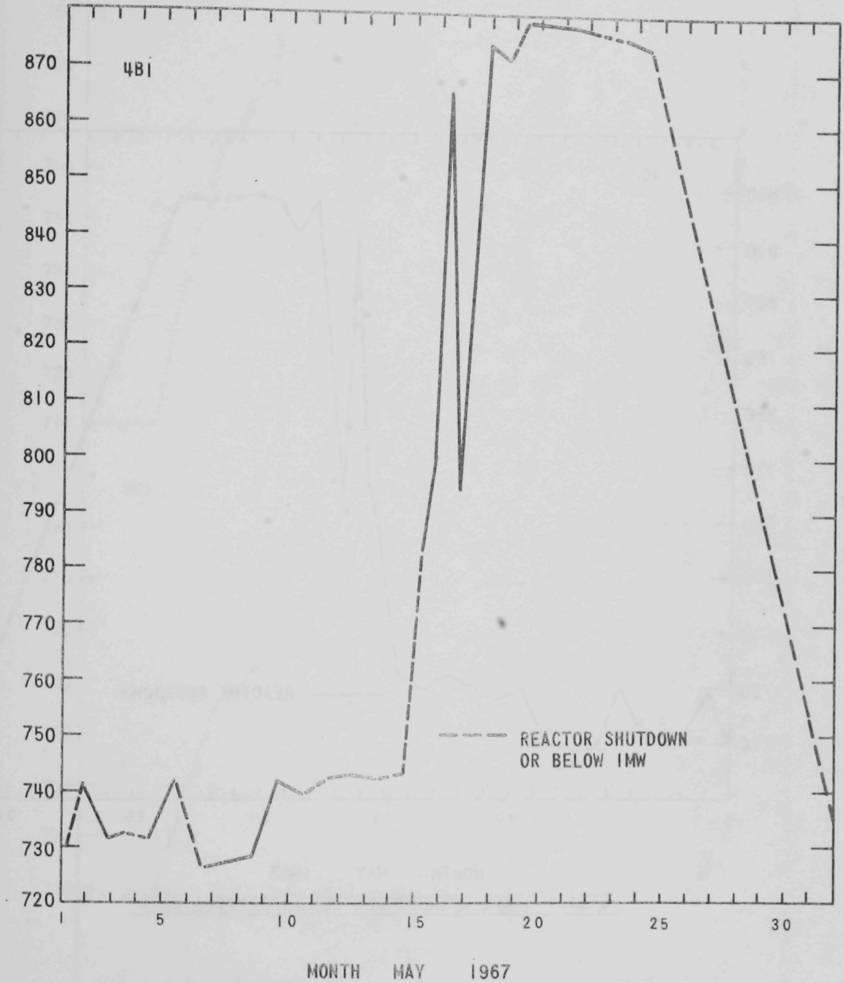
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURE

FIGURE 32

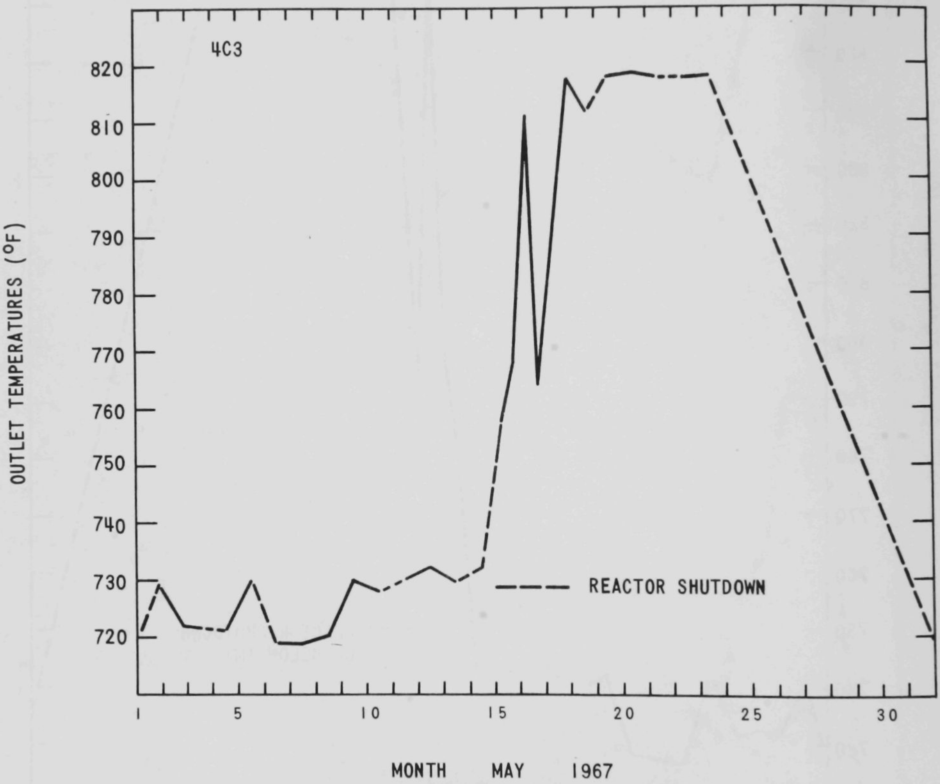


STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 33

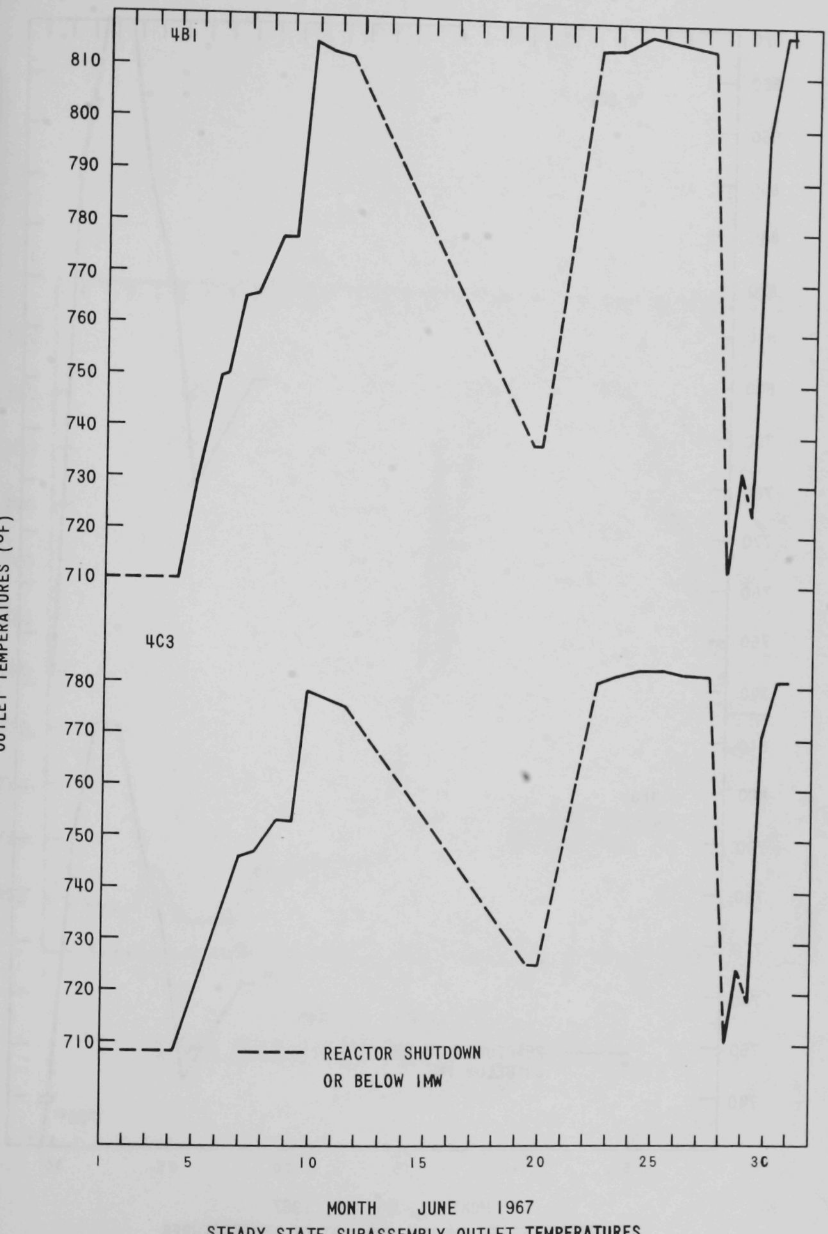


STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES



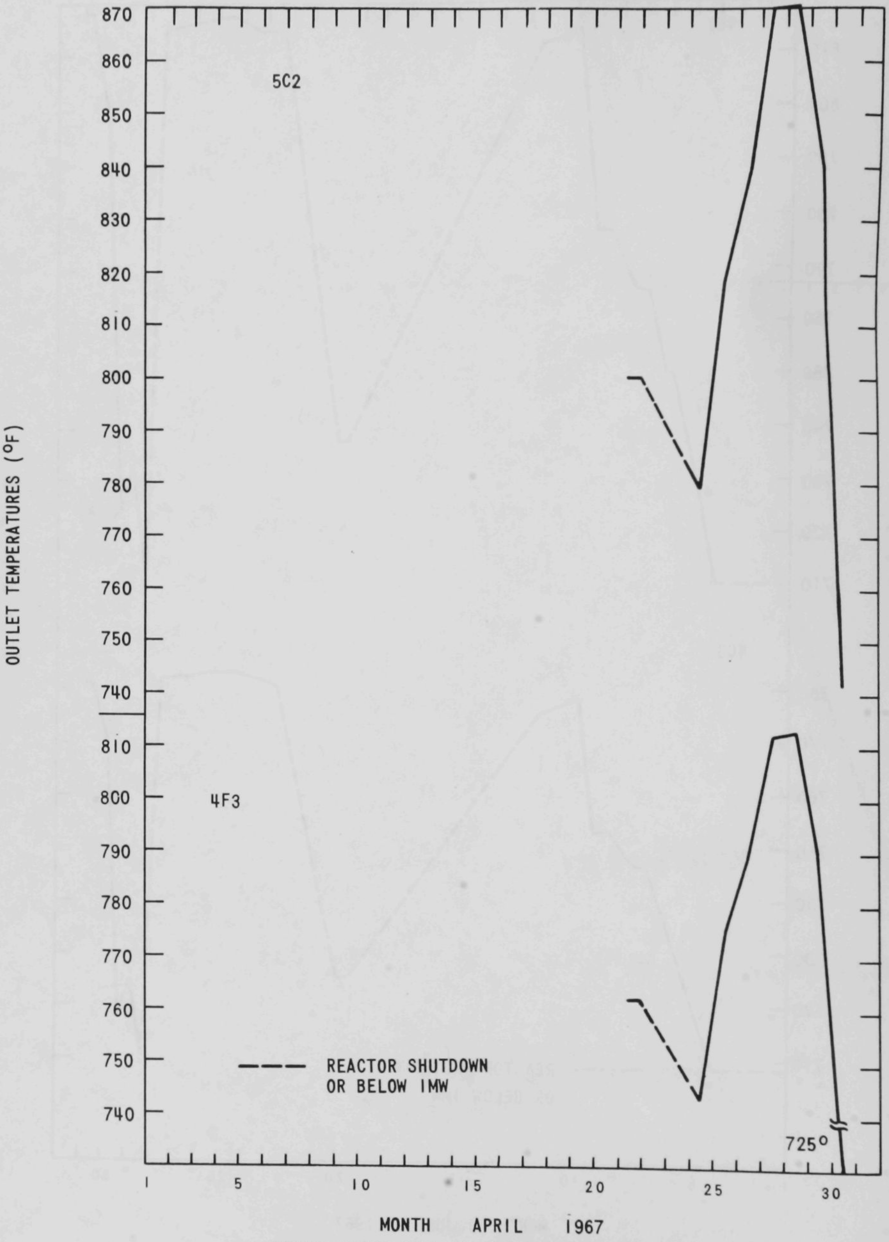
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 35



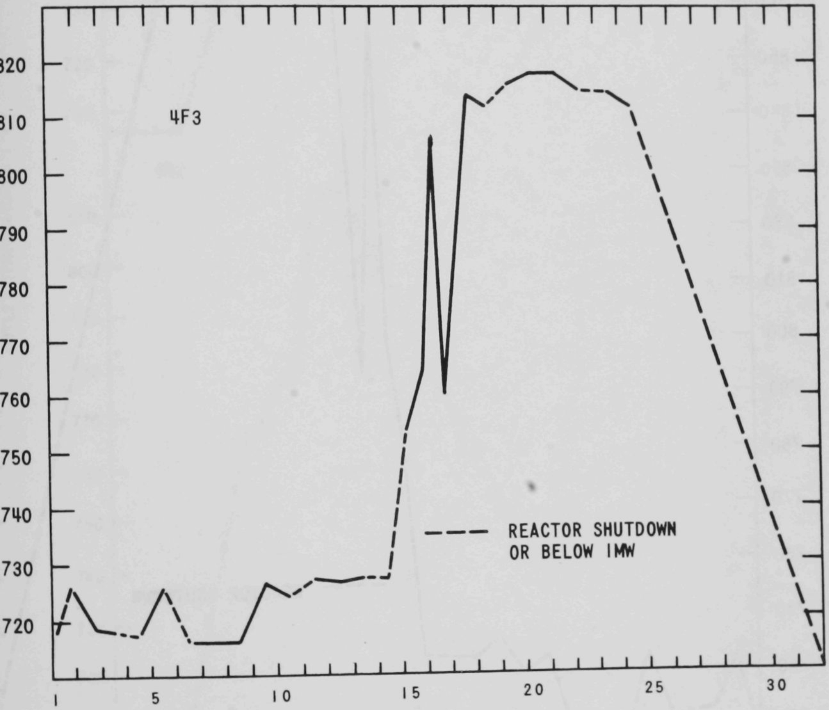
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 36



STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

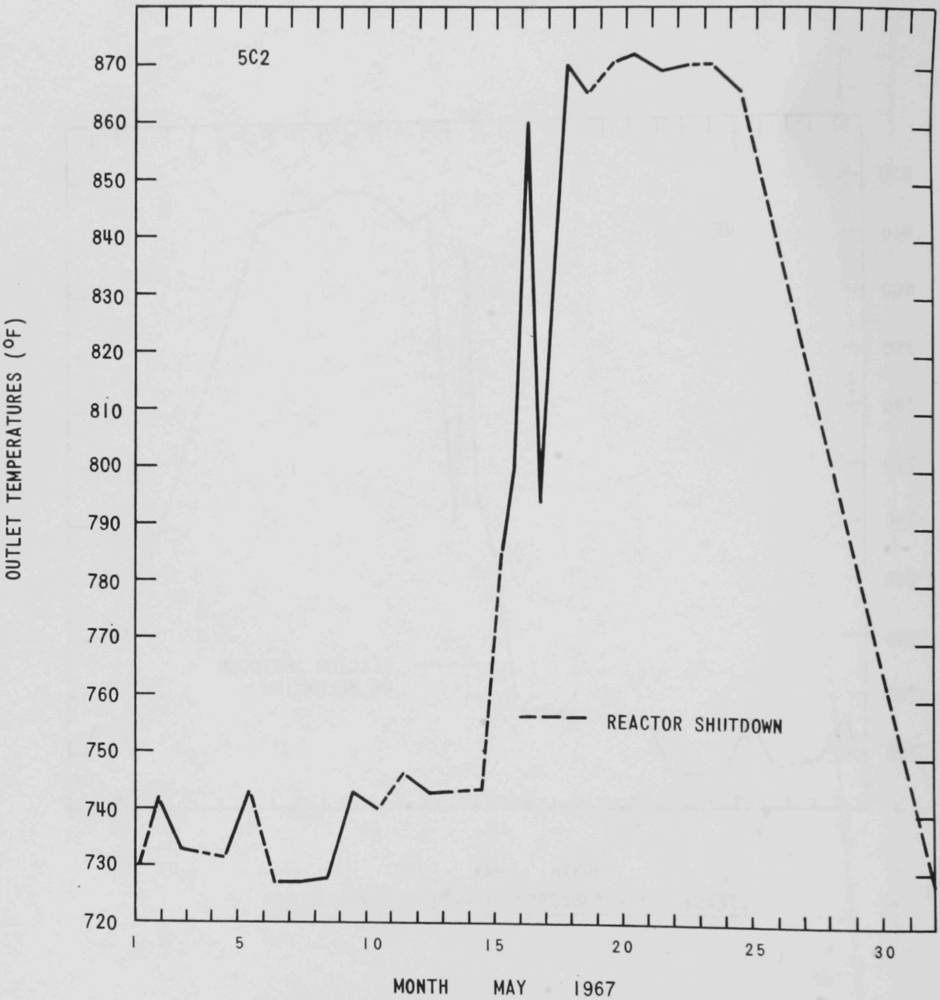
FIGURE 37



MONTH MAY 1967

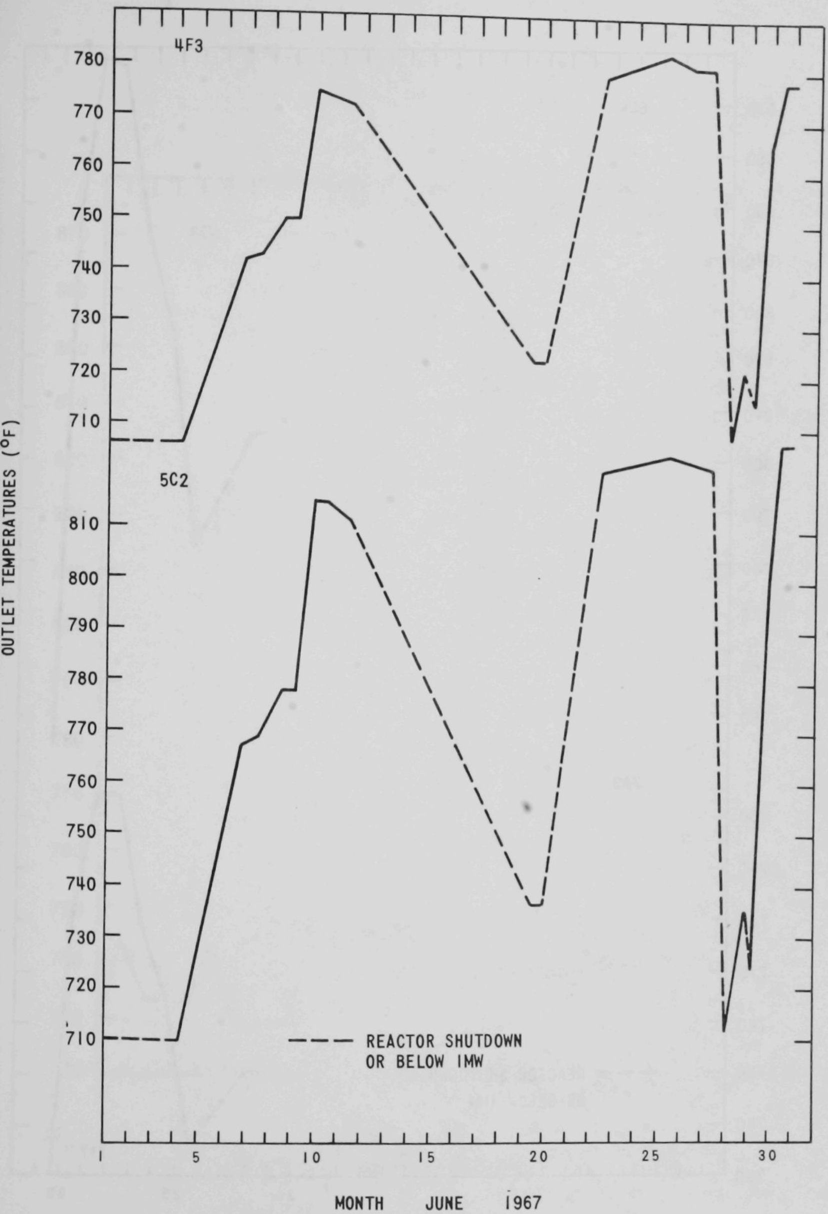
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 38



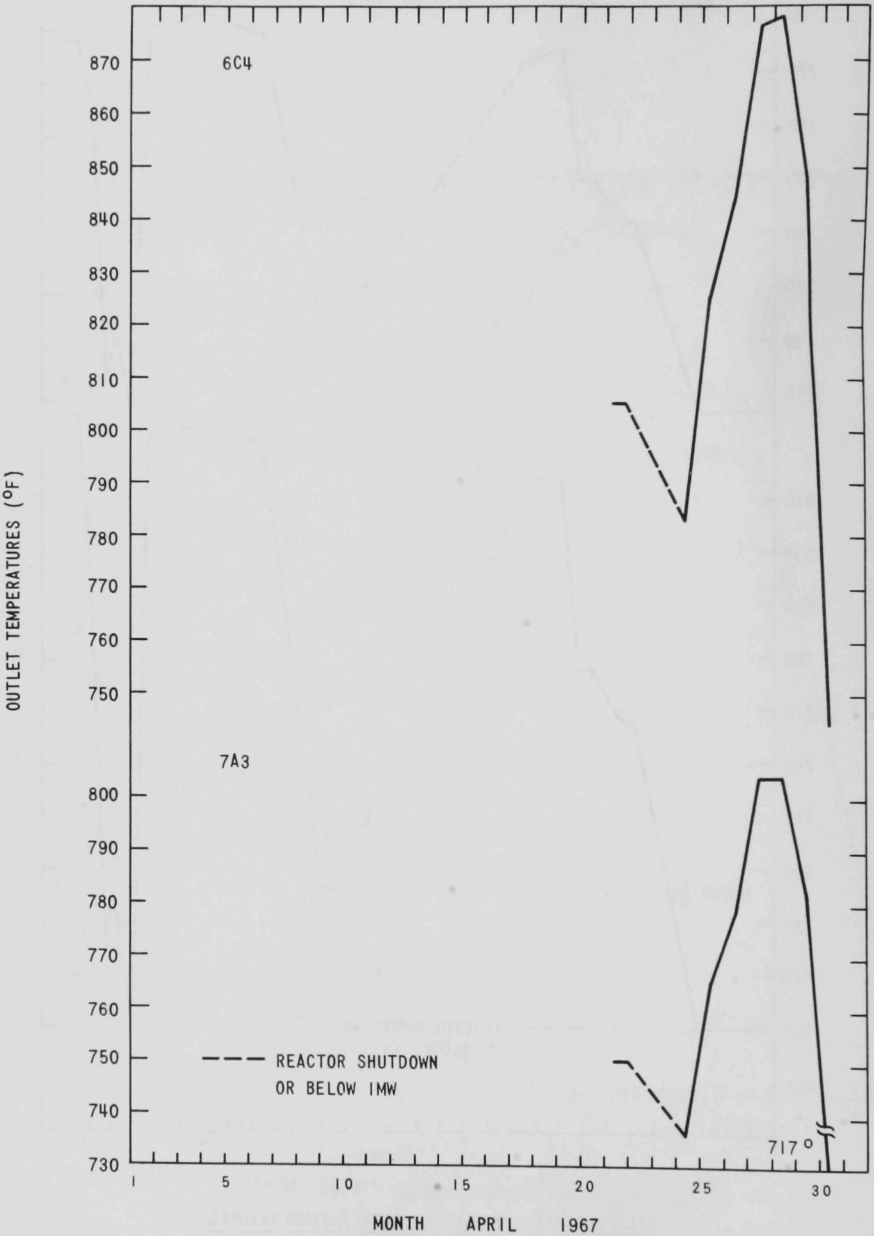
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 39



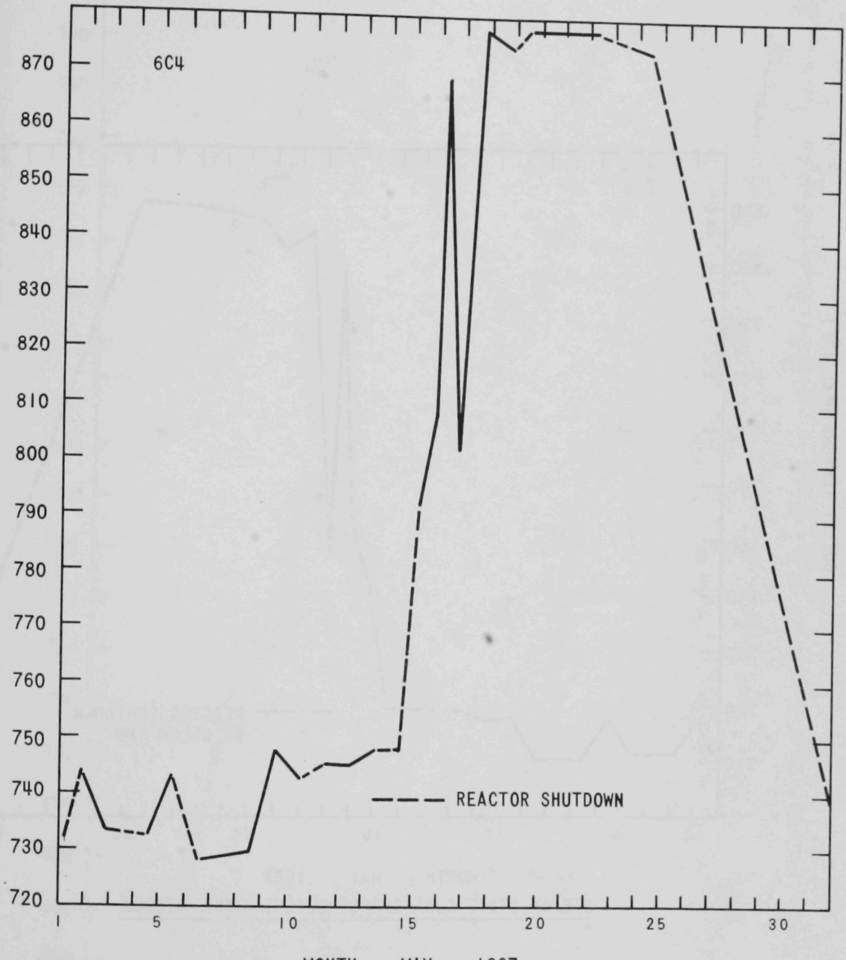
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 40



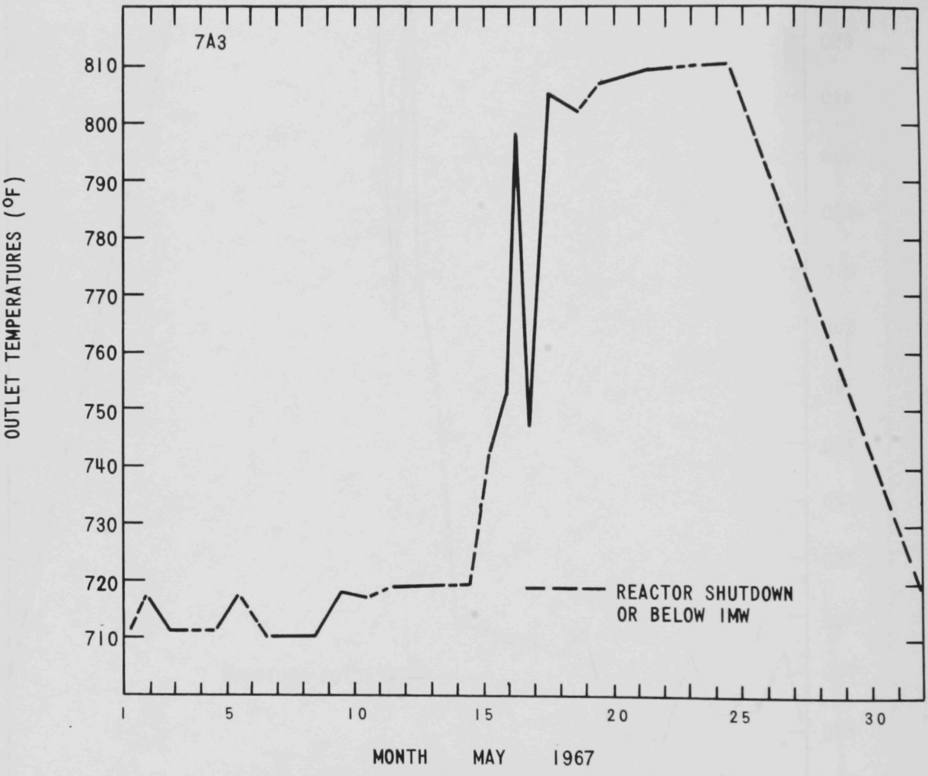
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 41



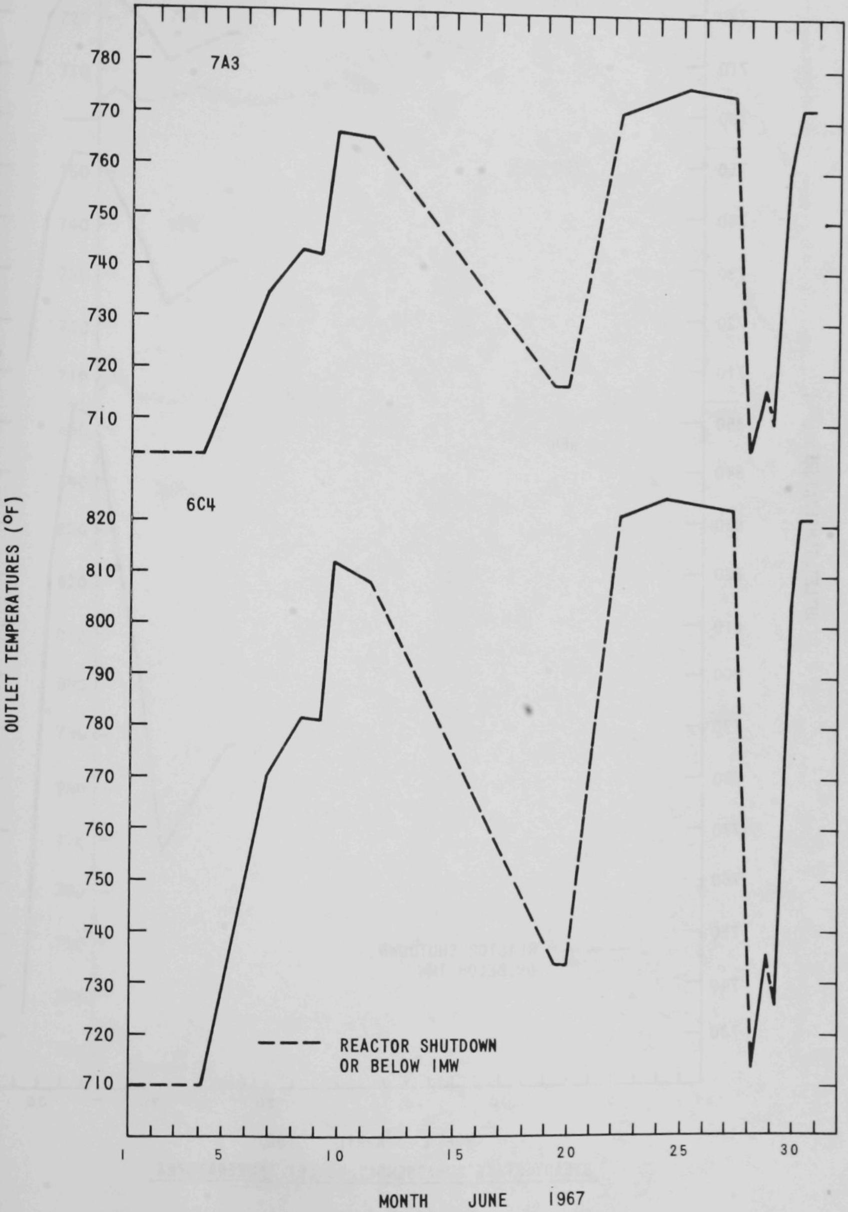
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 42



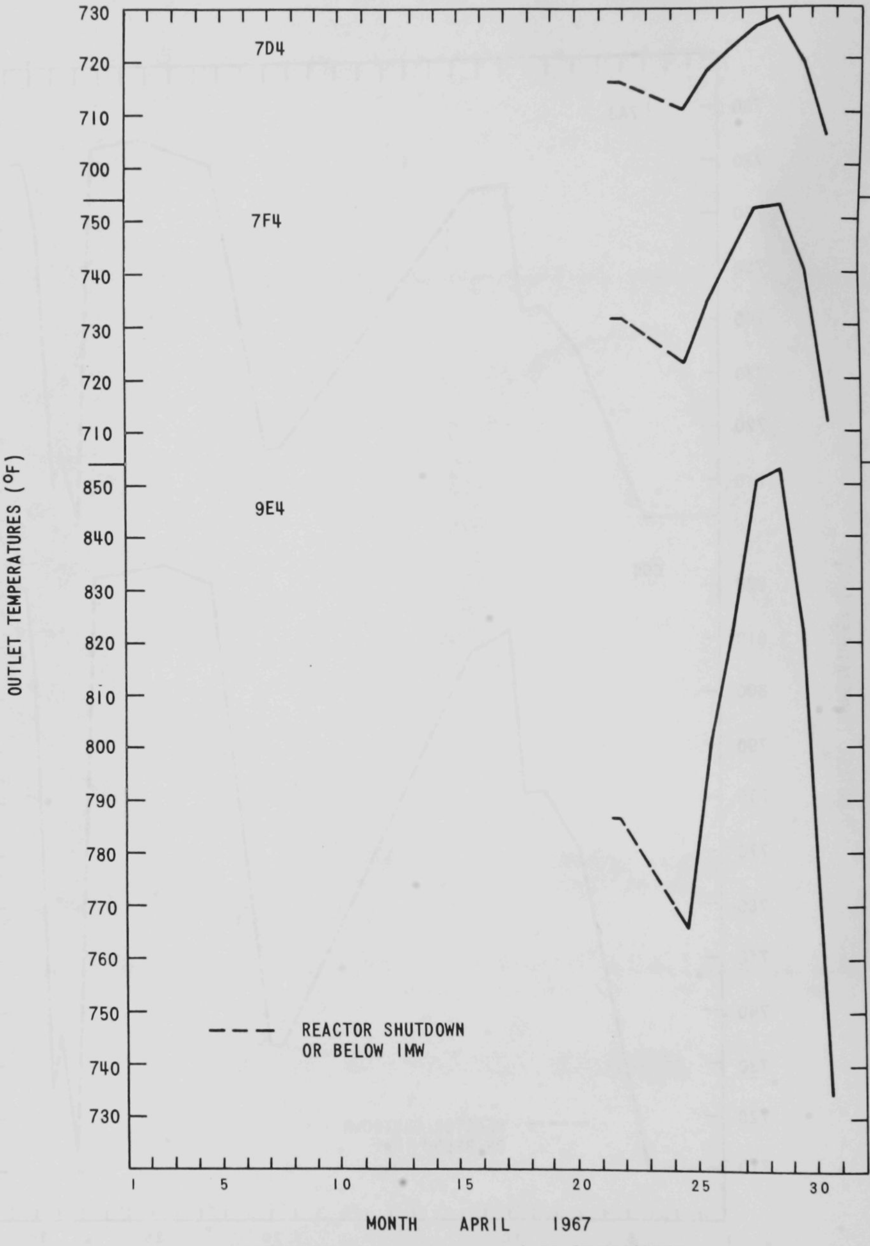
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 43



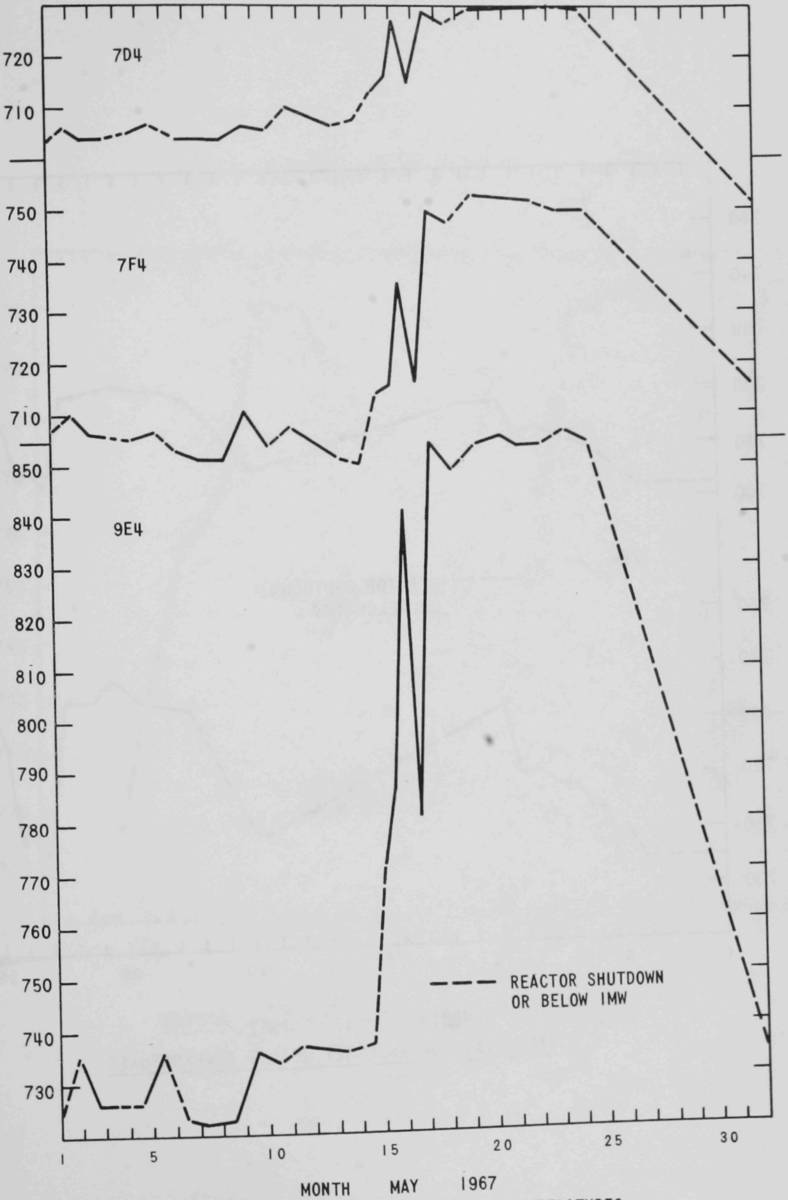
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 44



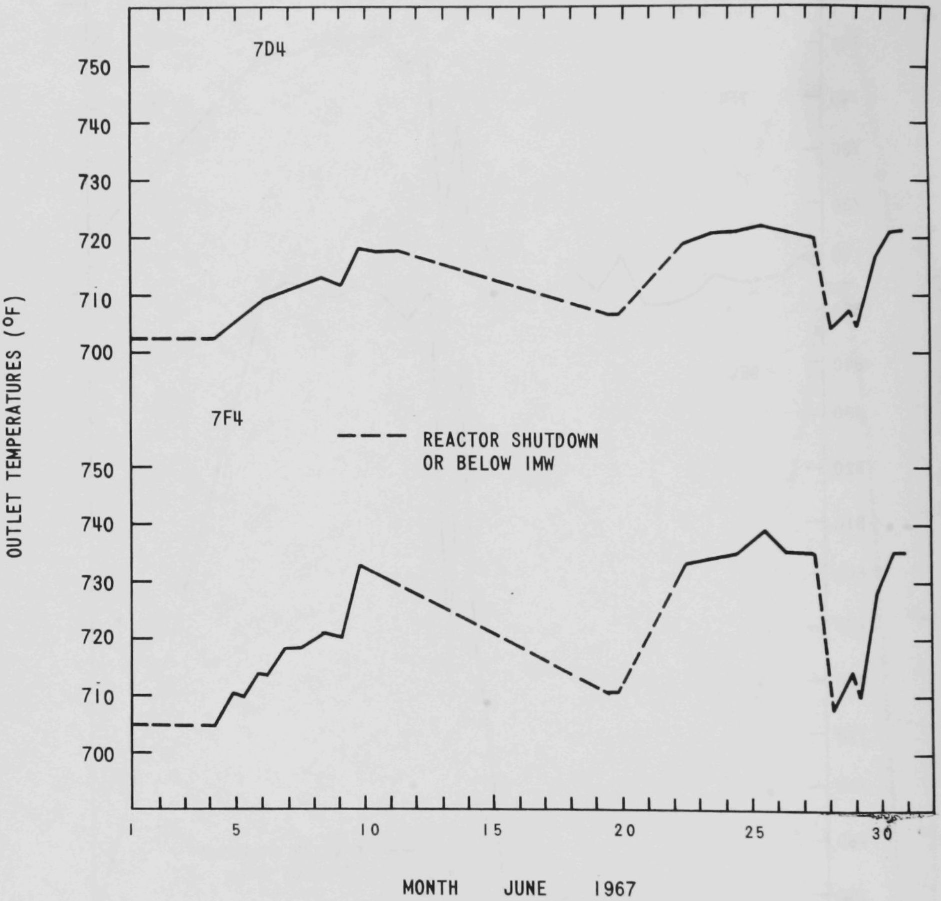
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 45



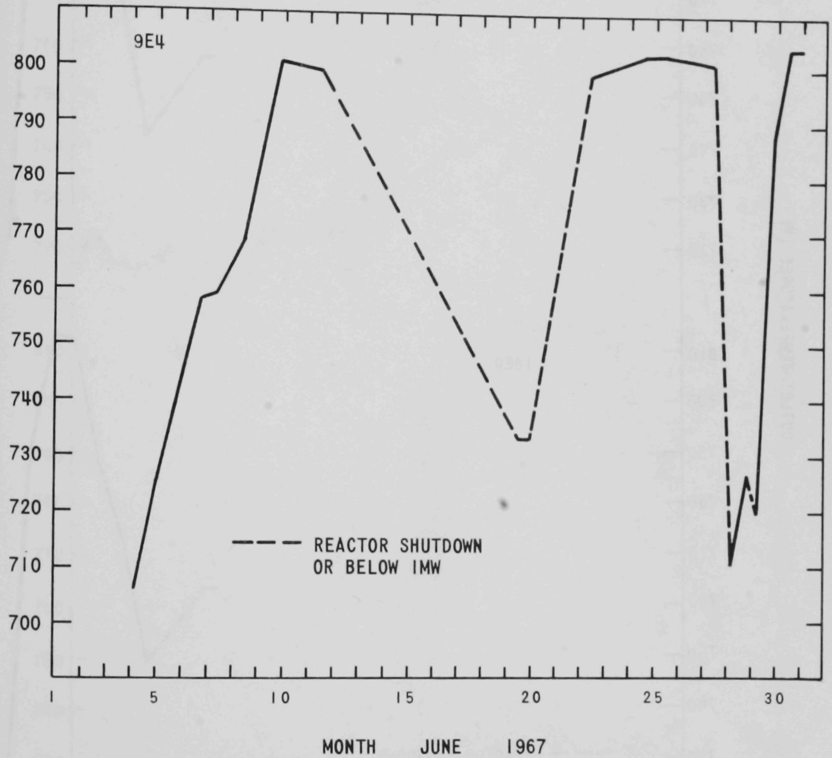
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 46



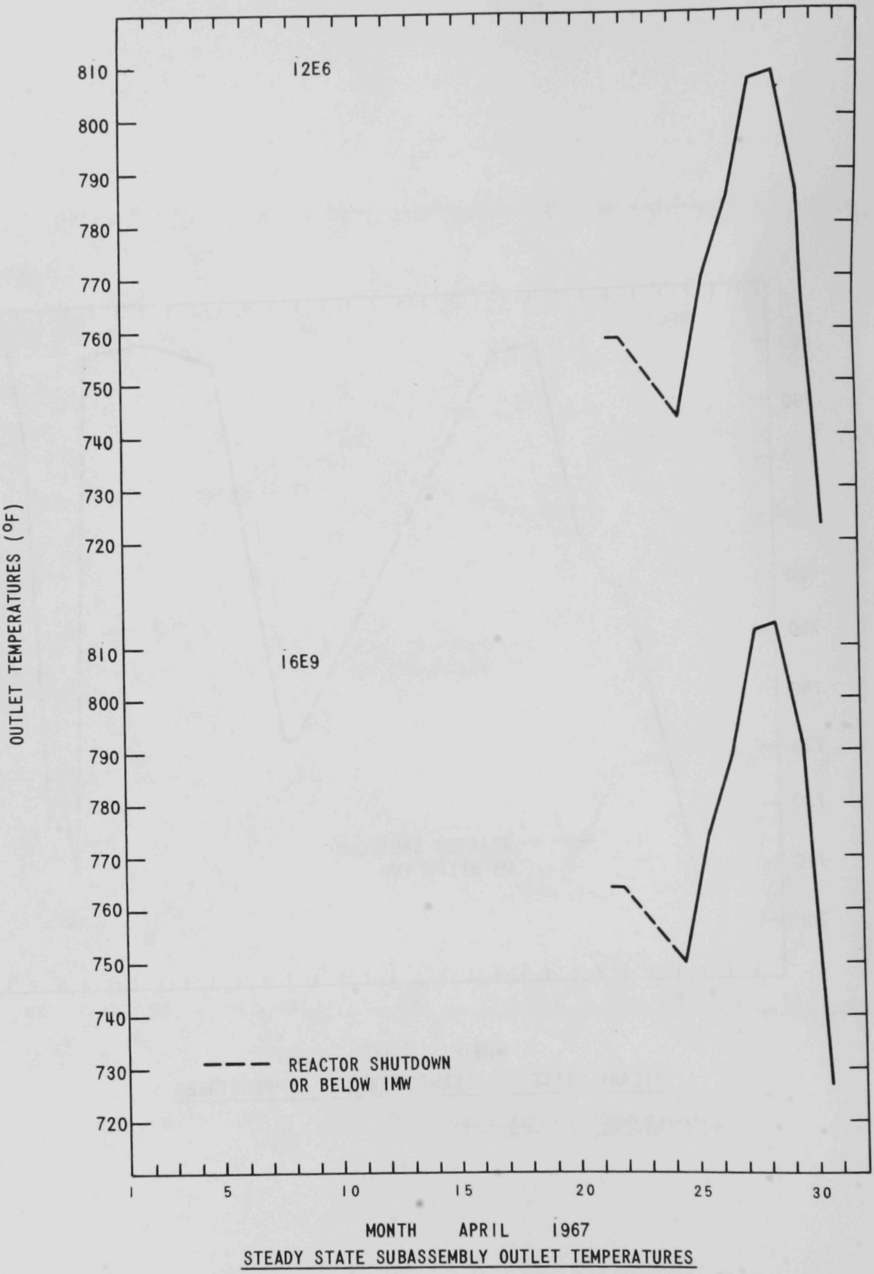
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 47



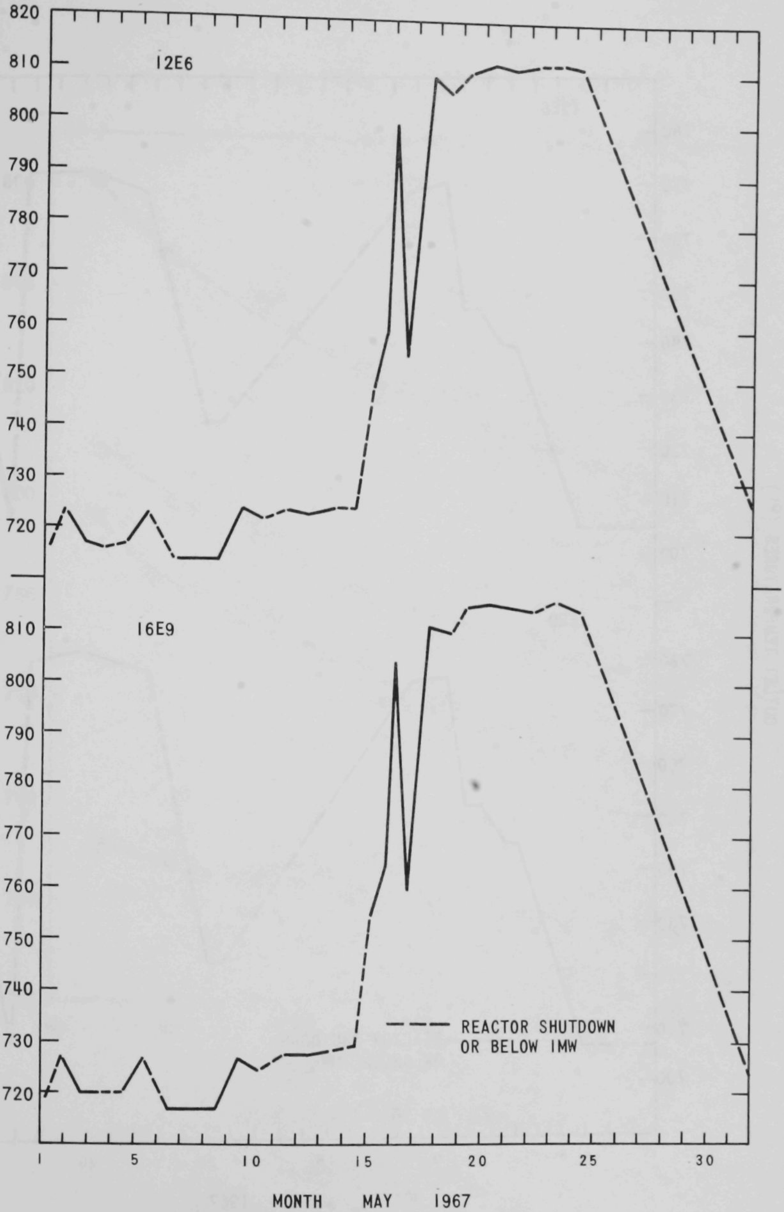
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 48



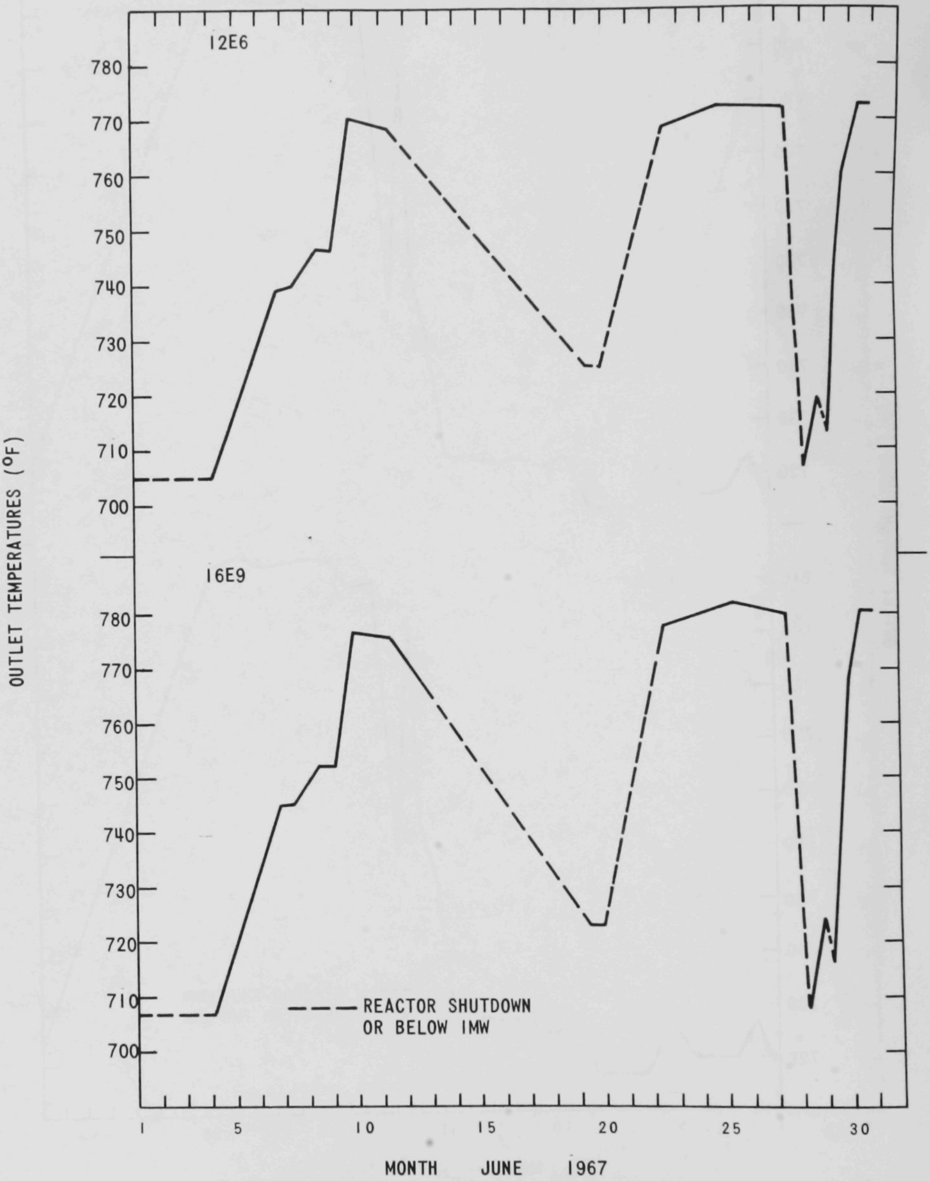
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 49



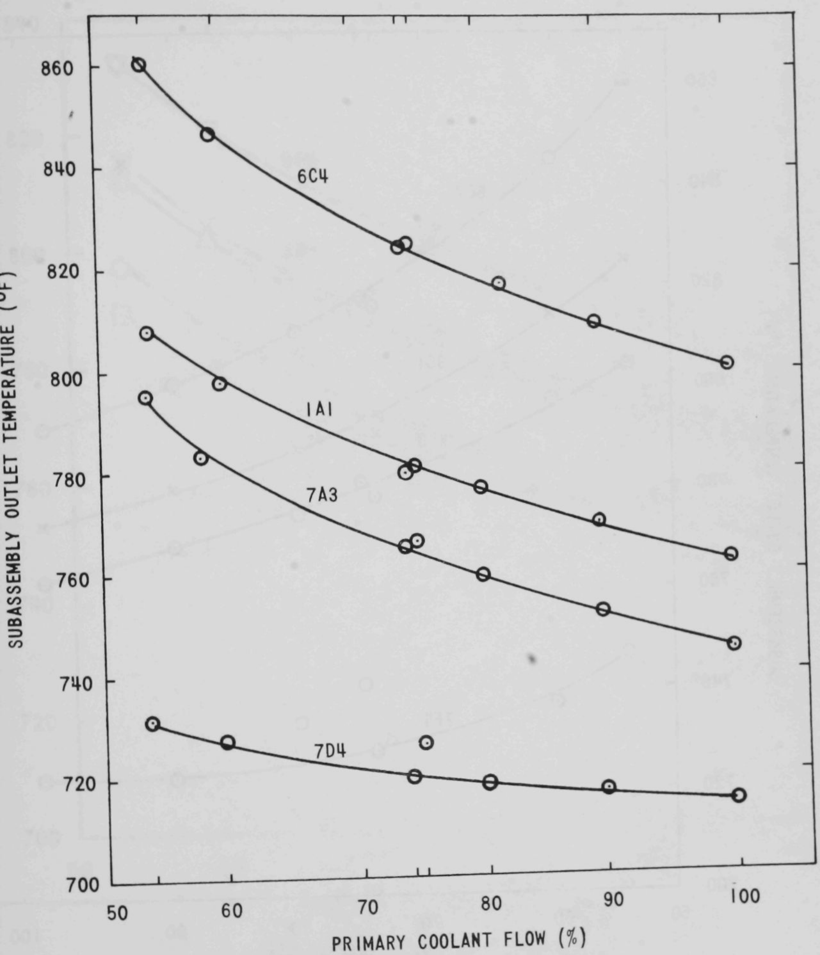
STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 50



STEADY STATE SUBASSEMBLY OUTLET TEMPERATURES

FIGURE 51



SUBASSEMBLY OUTLET TEMPERATURE

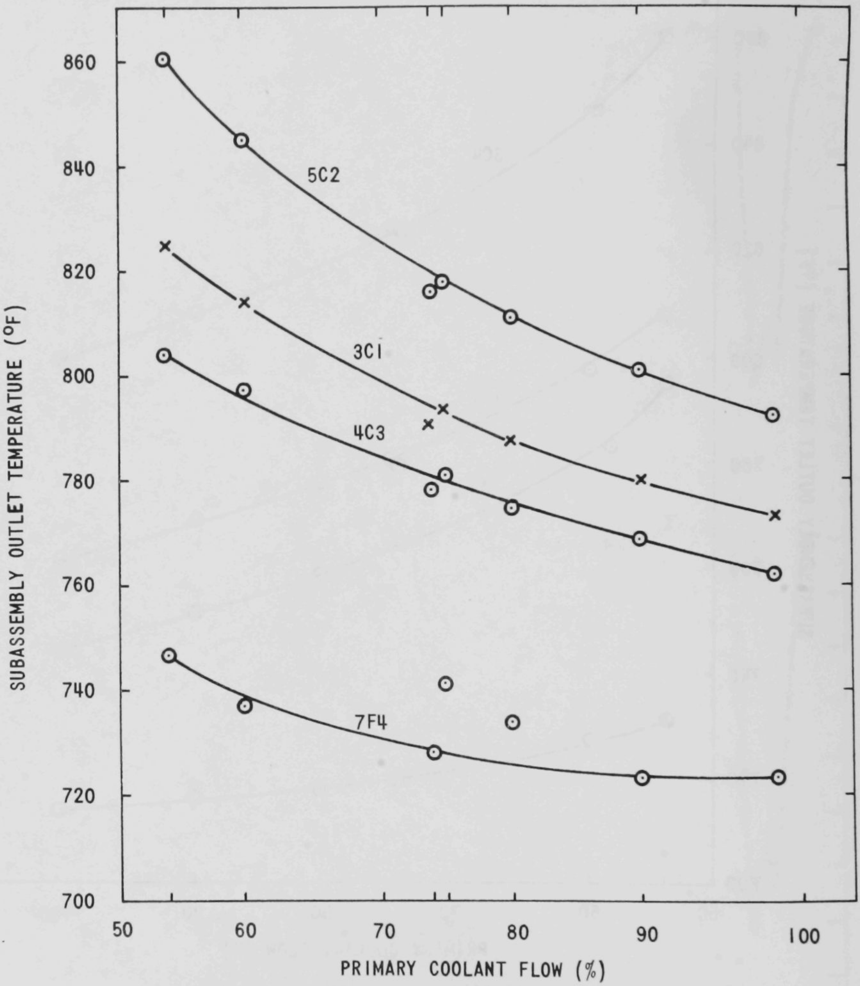
vs

PRIMARY COOLANT FLOW

22.2 Mwt RUN 25

5/16 & 17/67

FIGURE 52



SUBASSEMBLY OUTLET TEMPERATURES

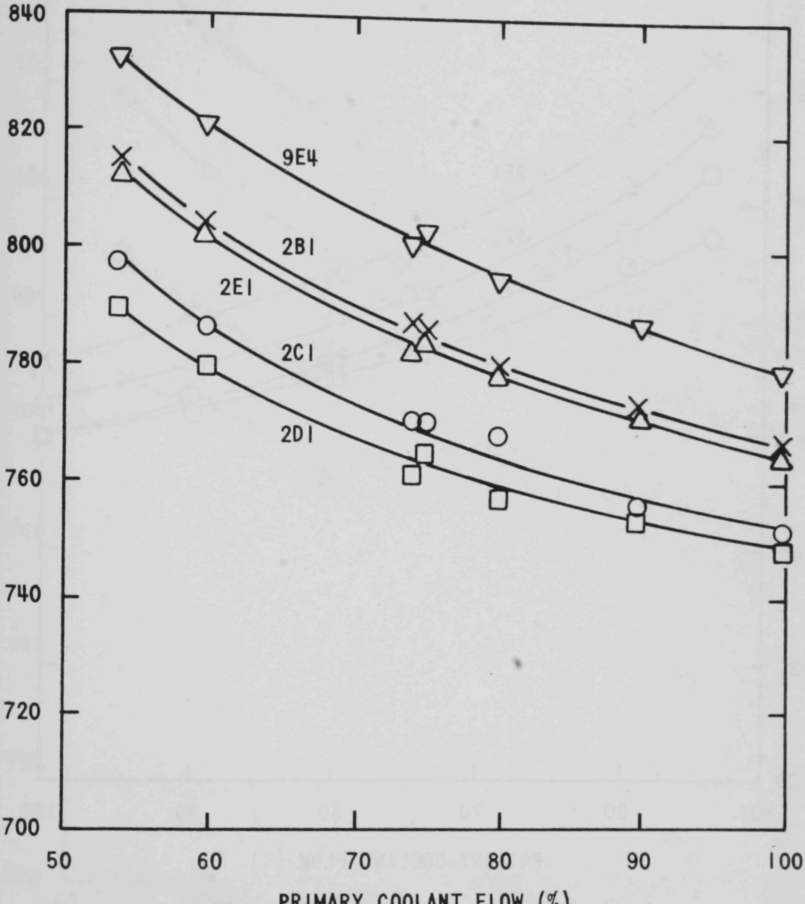
vs

PRIMARY COOLANT FLOW

22.2 Mwt RUN 25

5/16 & 17/67

FIGURE 53



SUBASSEMBLY OUTLET TEMPERATURE

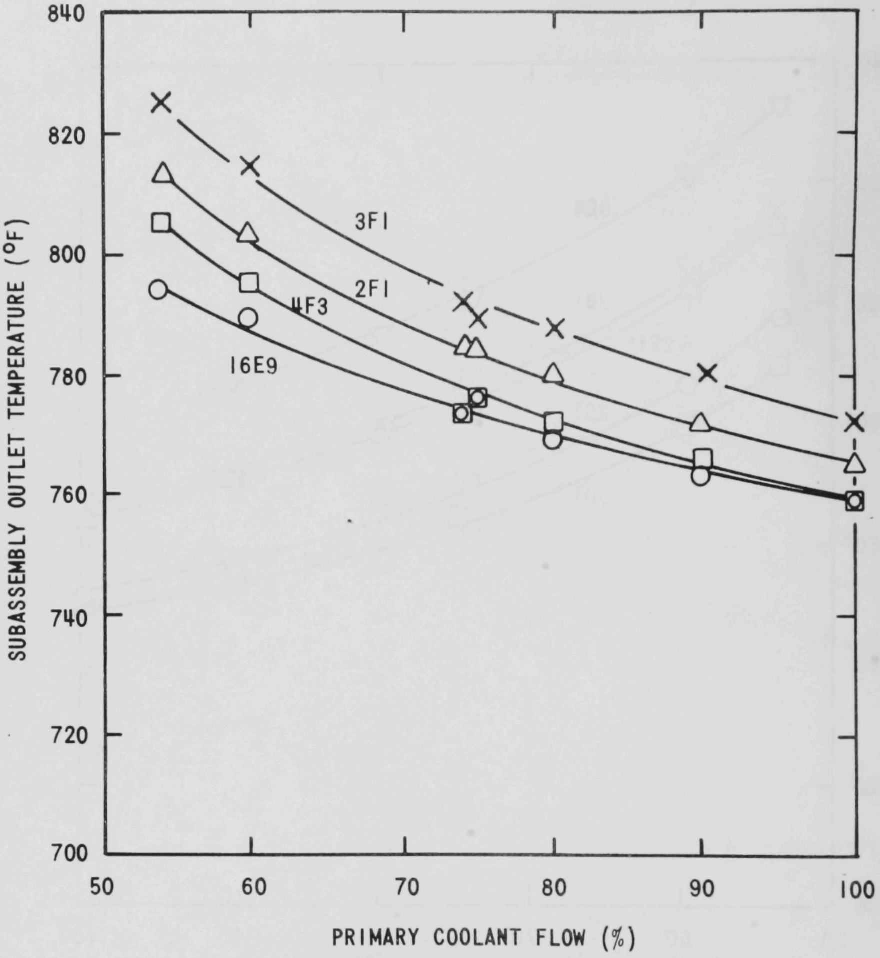
vs

PRIMARY COOLANT FLOW

22.2 Mwt RUN 25

5/16 & 17/67

FIGURE 54



SUBASSEMBLY OUTLET TEMPERATURE

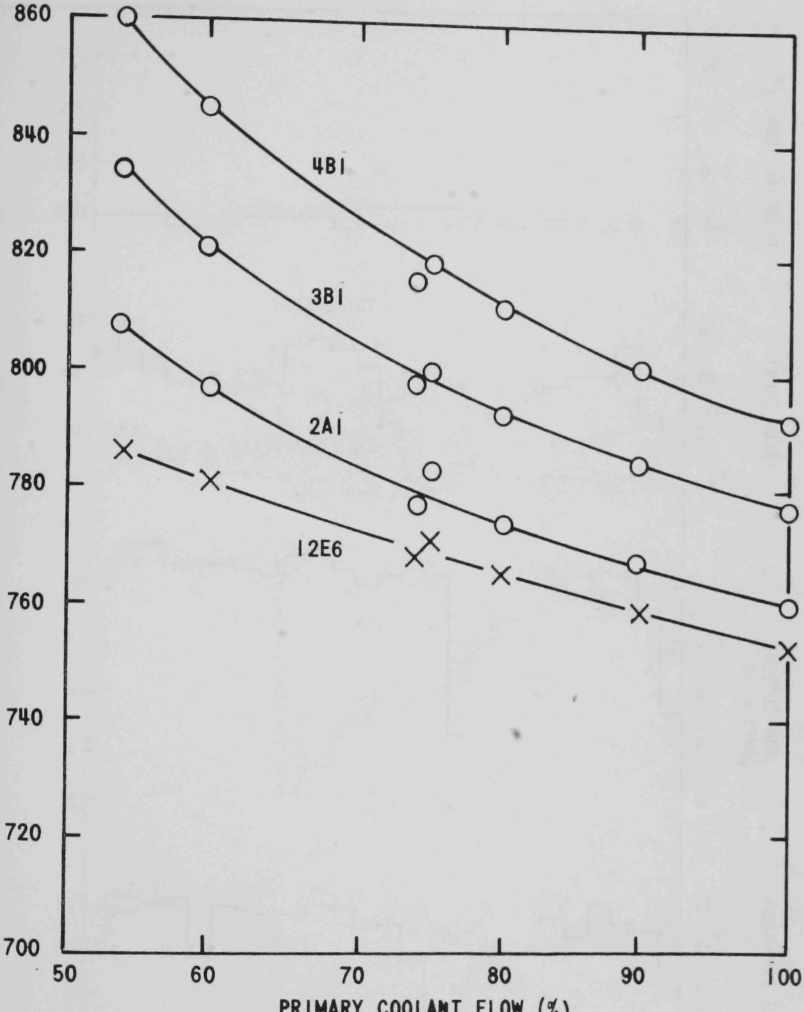
vs

PRIMARY COOLANT FLOW

22.5 Mwt RUN 25

5/16 & 17/67

FIGURE 55



SUBASSEMBLY OUTLET TEMPERATURE

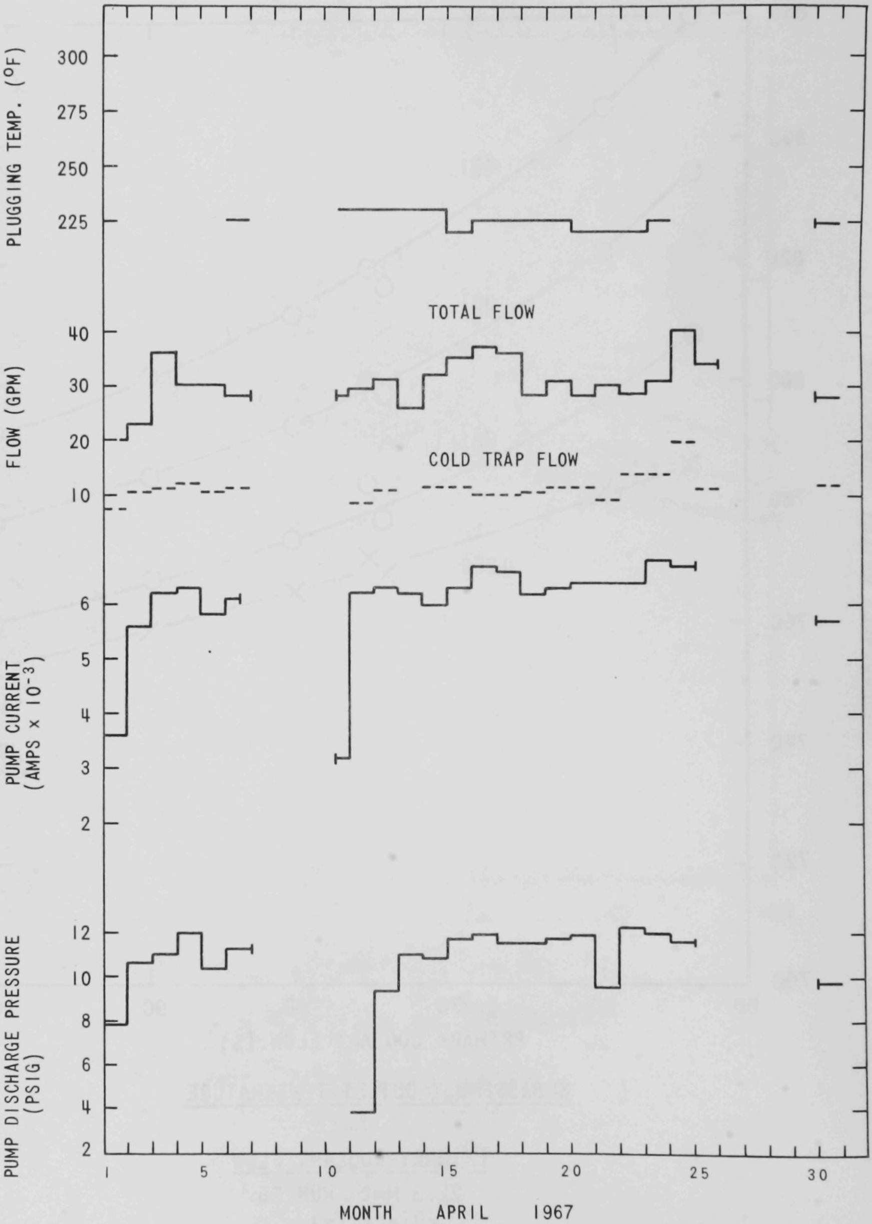
vs

PRIMARY COOLANT FLOW

22.5 Mwt RUN 25

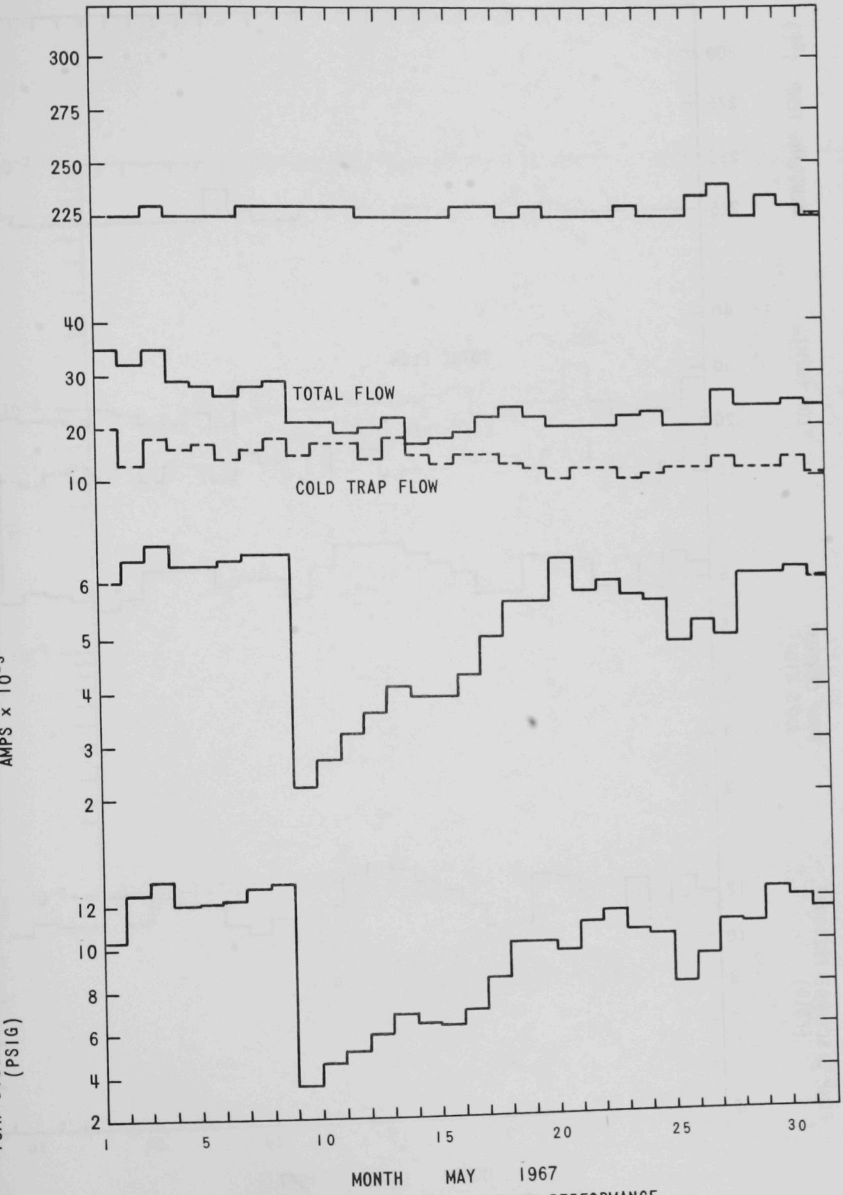
5/16 & 17/67

FIGURE 56



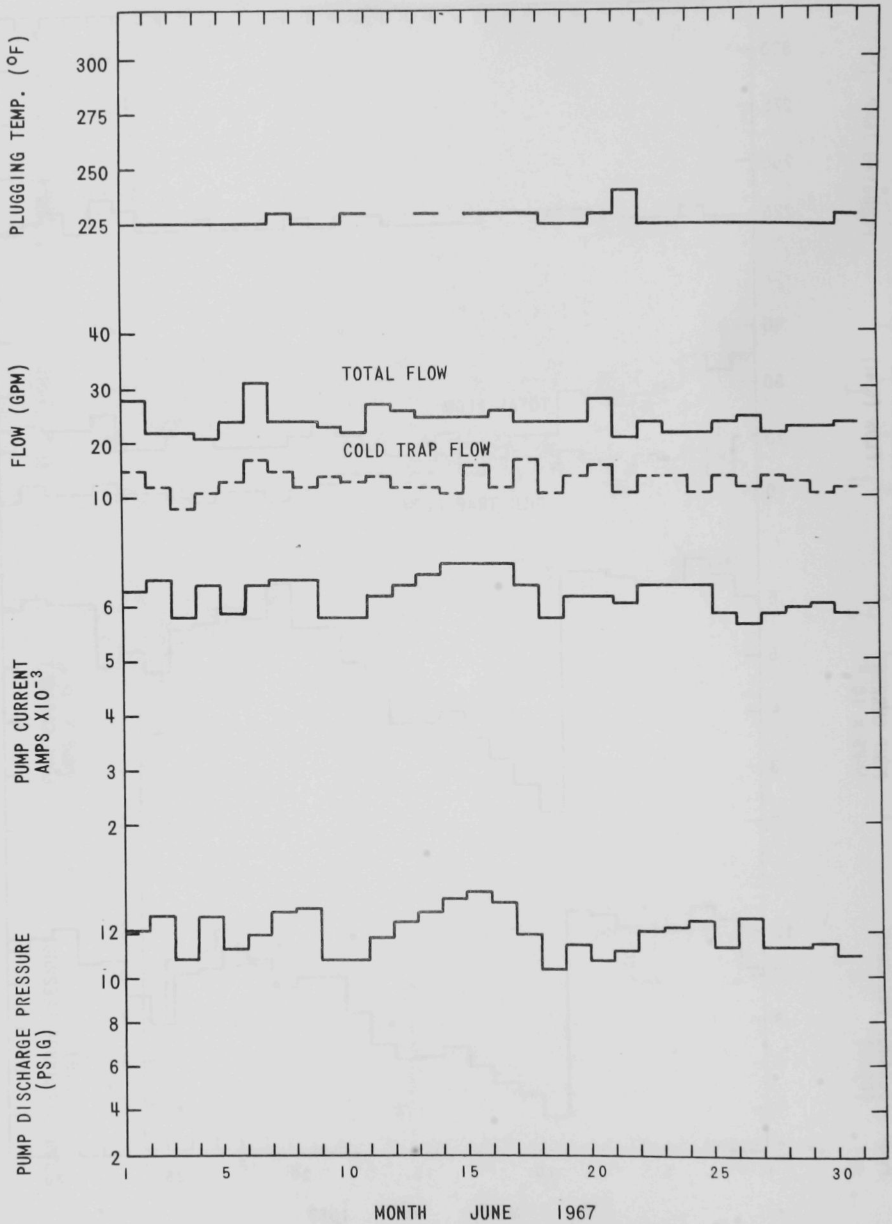
PRIMARY PURIFICATION SYSTEM PERFORMANCE

FIGURE 57



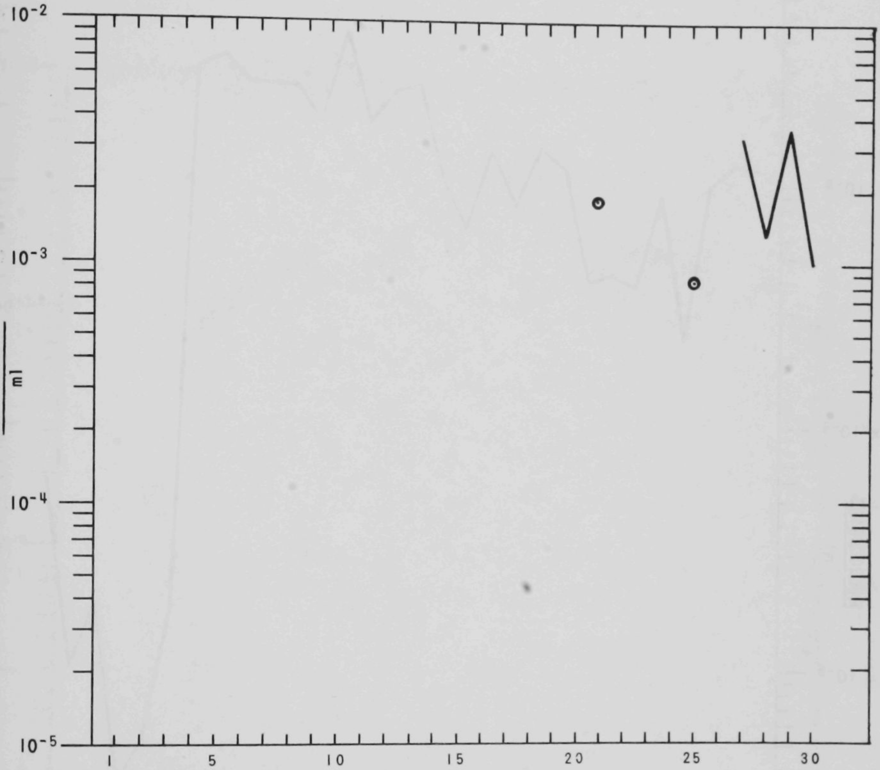
PRIMARY PURIFICATION SYSTEM PERFORMANCE

FIGURE 58



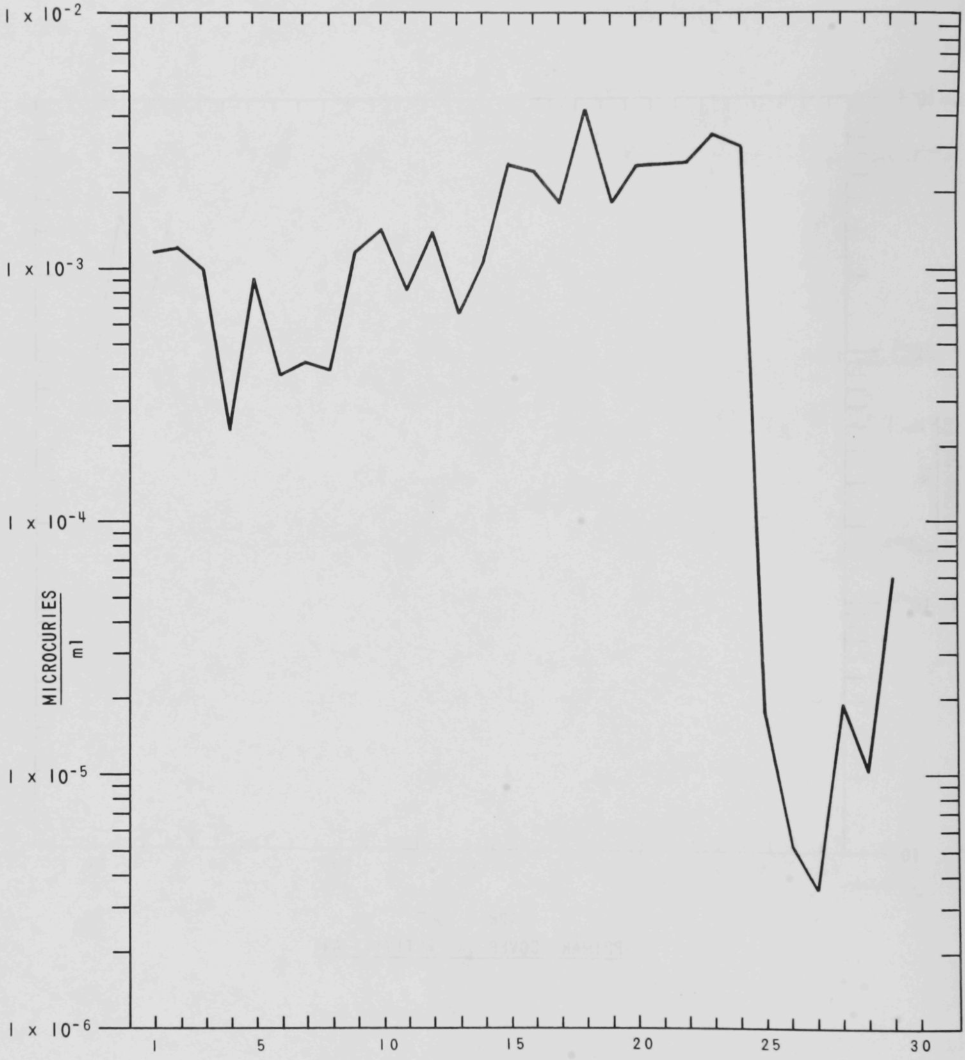
PRIMARY PURIFICATION SYSTEM PERFORMANCE

FIGURE 5.9



APRIL 1967
PRIMARY COVER GAS ACTIVITY-A41

FIGURE 60



MAY 1967

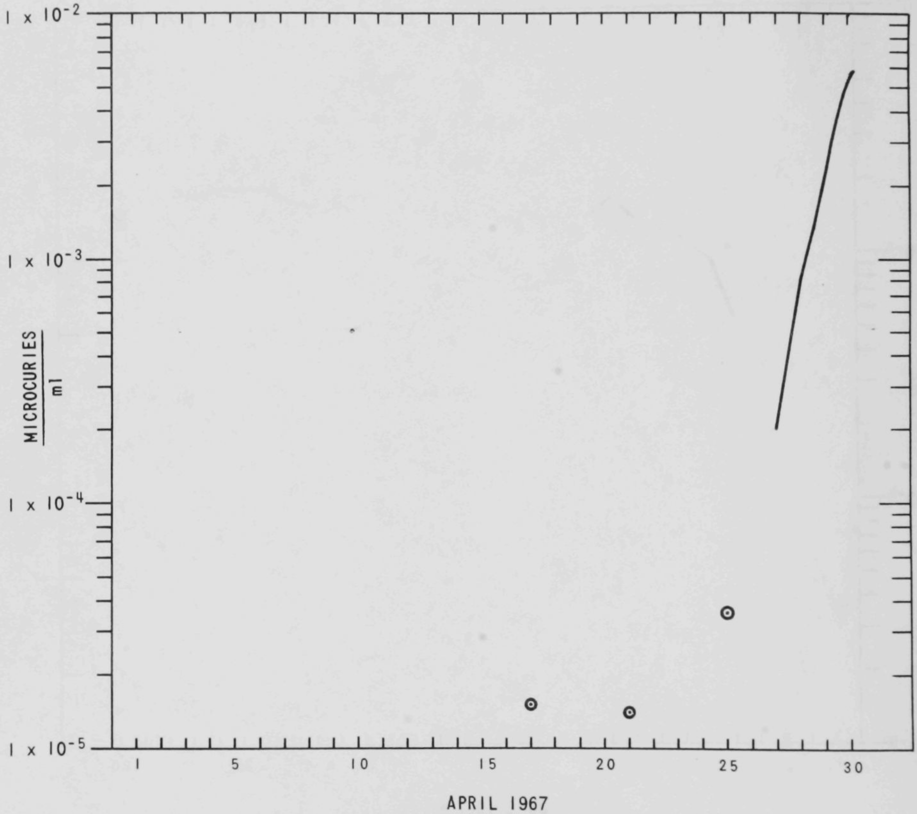
PRIMARY COVER GAS ACTIVITY-A41

FIGURE 61

JUNE 1967

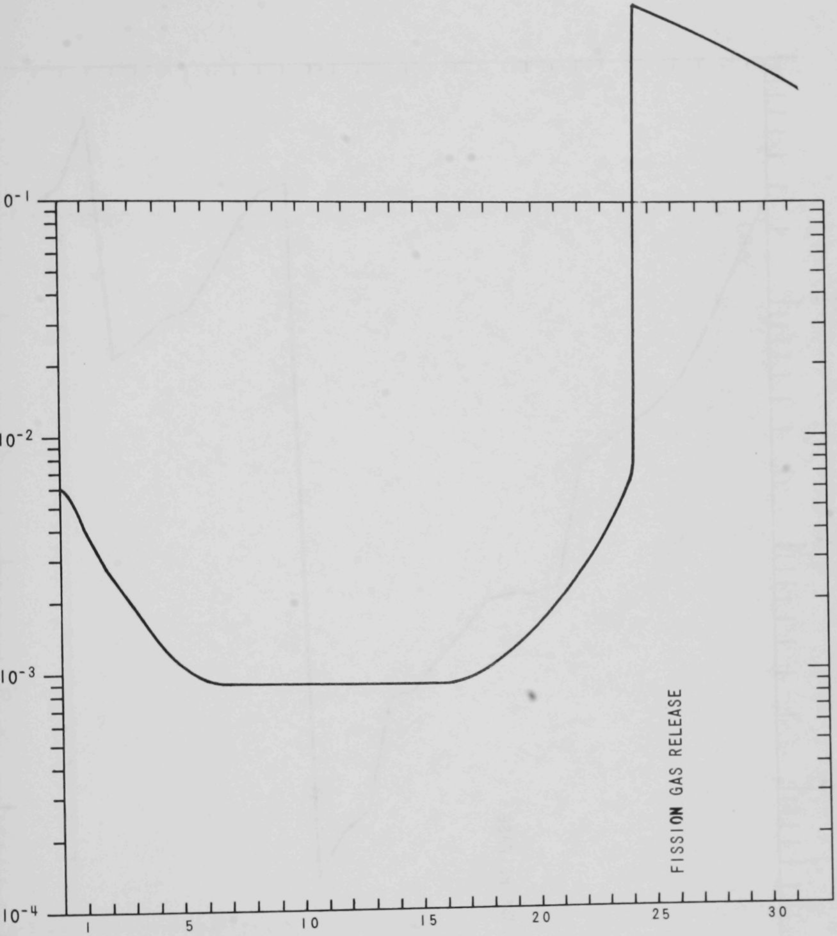
PRIMARY COVER GAS ACTIVITY-A41

FIGURE 62



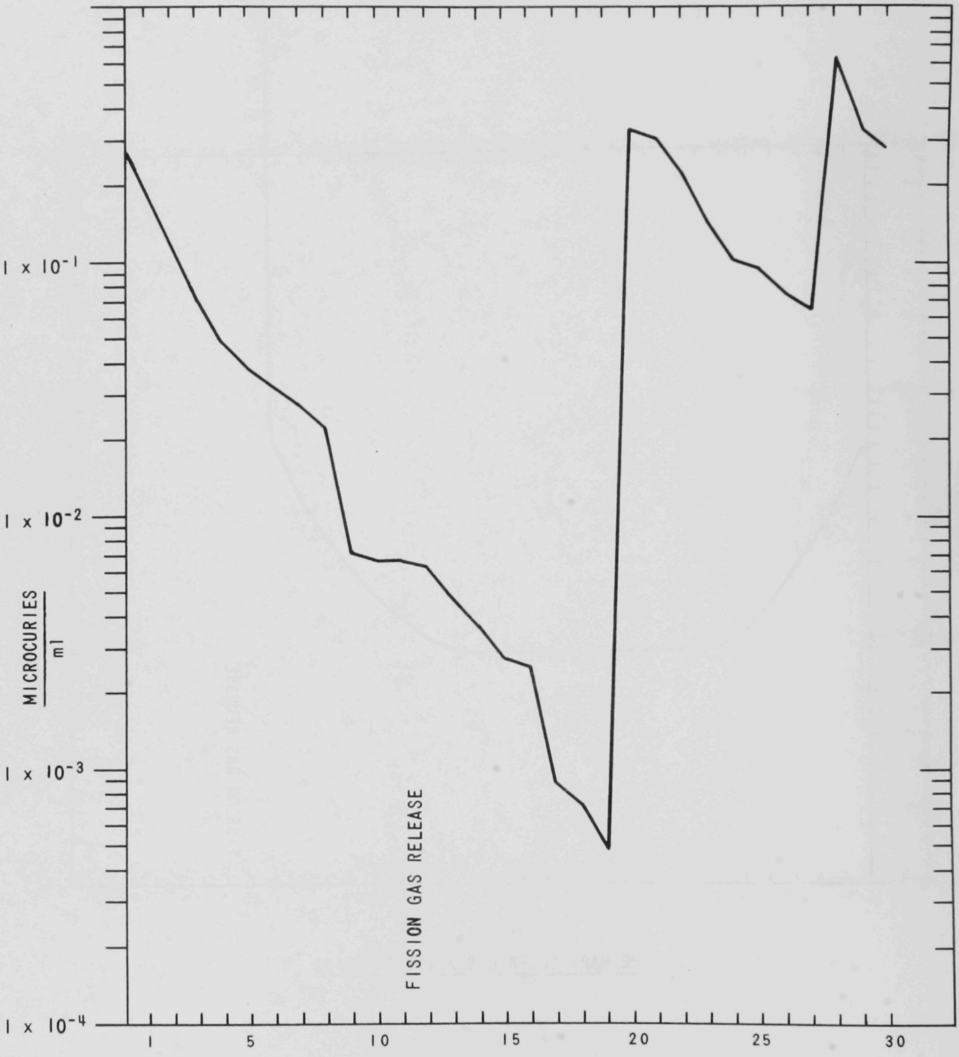
PRIMARY COVER GAS ACTIVITY-Xe133

FIGURE 63



PRIMARY COVER GAS ACTIVITY-Xe133

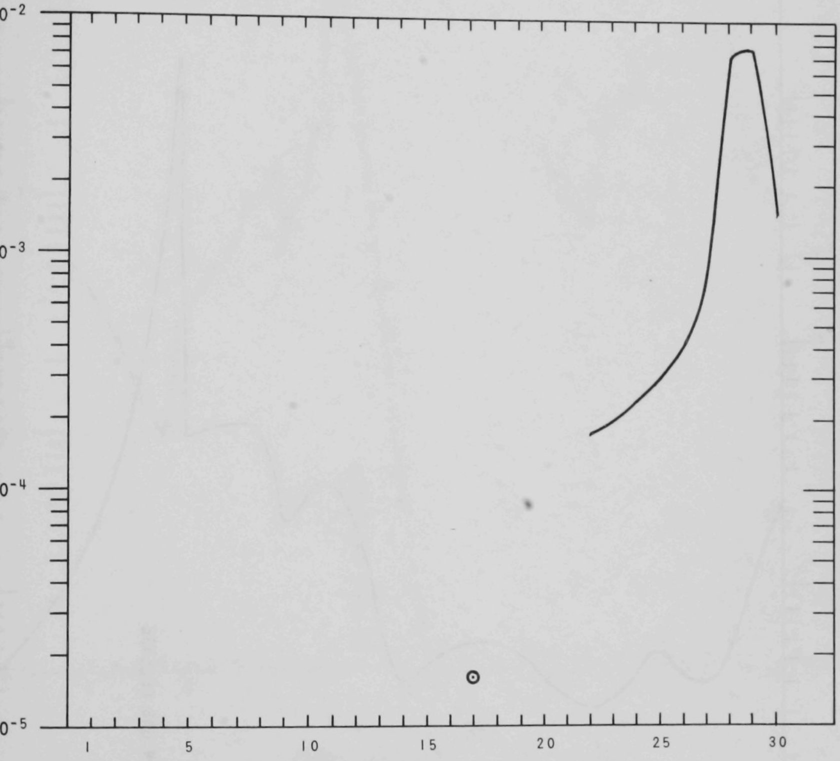
FIGURE 64



JUNE 1967

PRIMARY COVER GAS ACTIVITY-Xe133

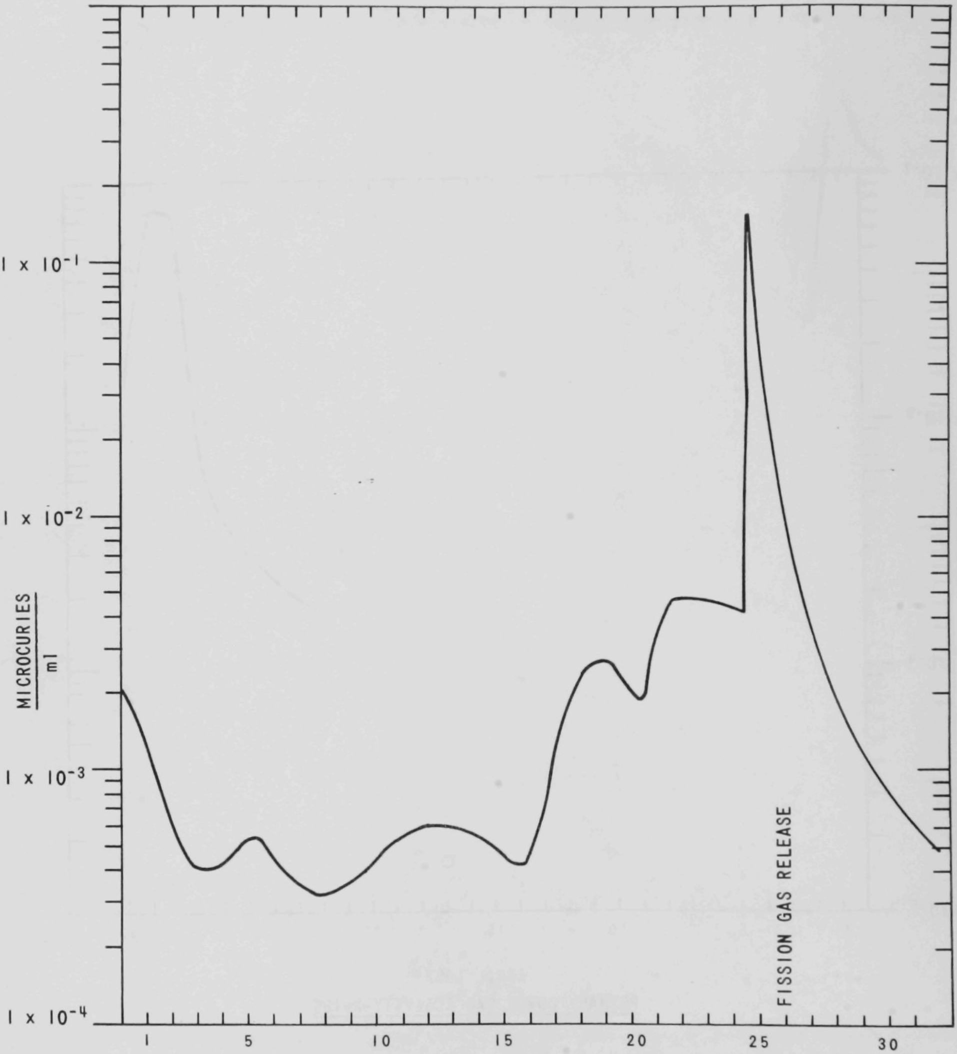
FIGURE 65



APRIL 1967

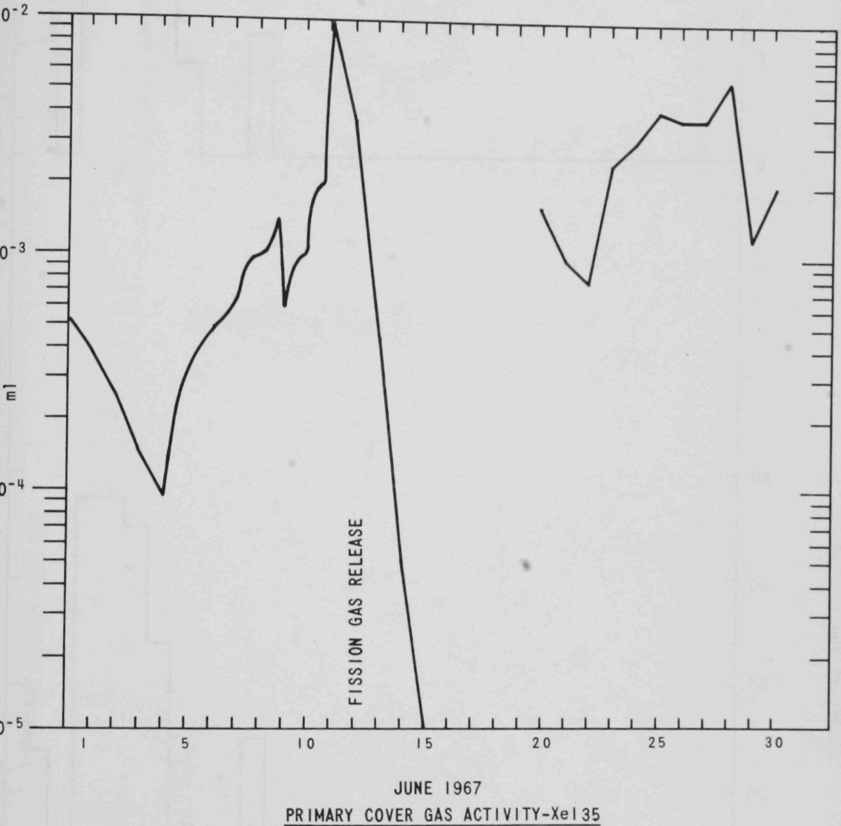
PRIMARY COVER GAS ACTIVITY-Xe135

FIGURE 66



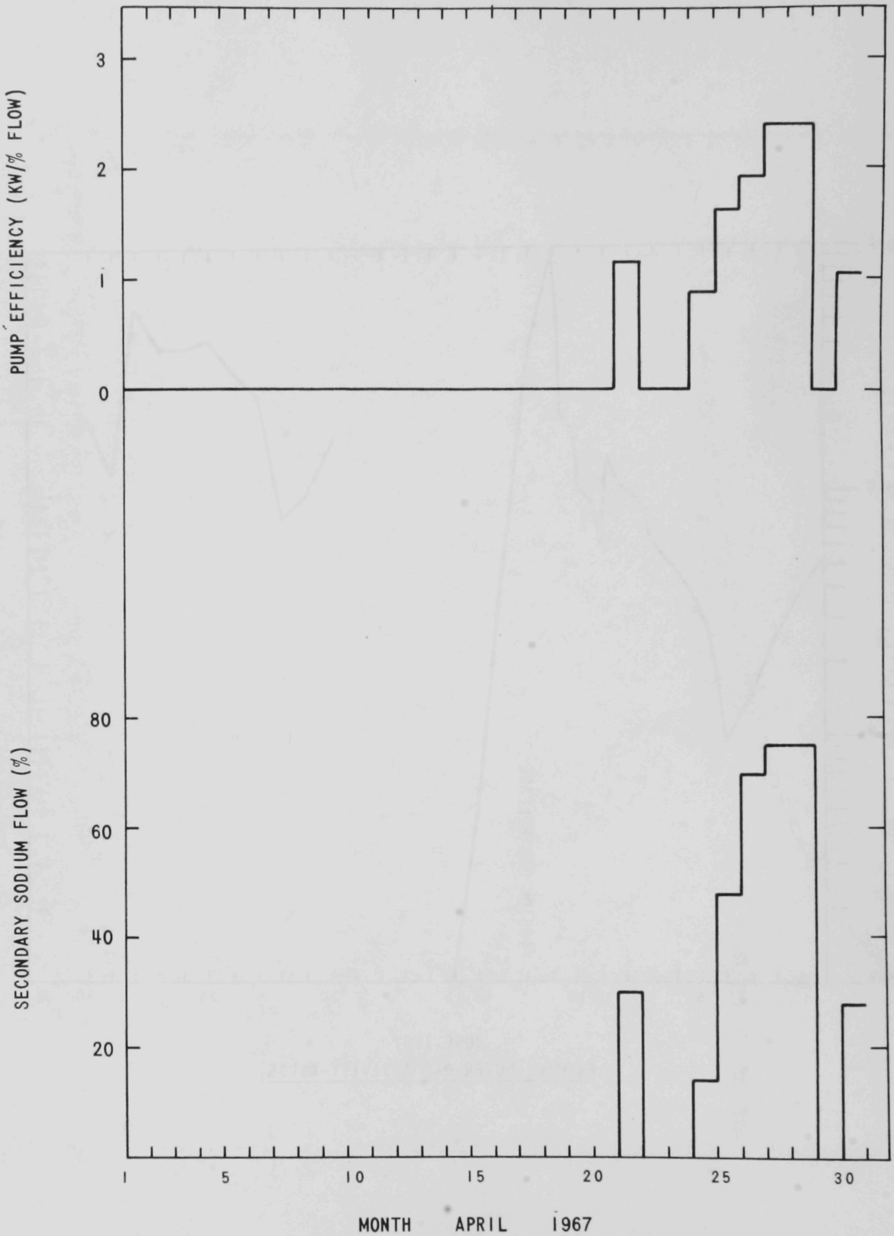
PRIMARY COVER GAS ACTIVITY-Xe135

FIGURE 67



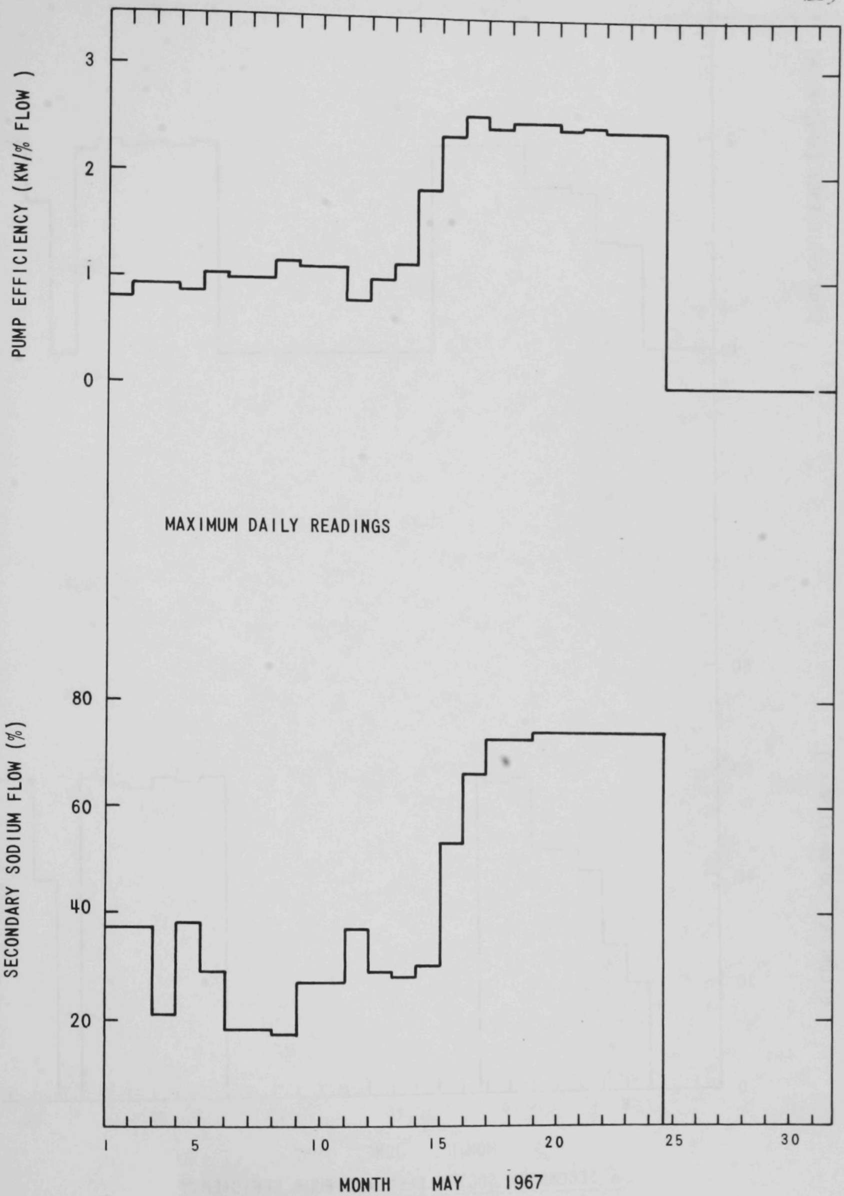
PRIMARY COVER GAS ACTIVITY-Xe135

FIGURE 68



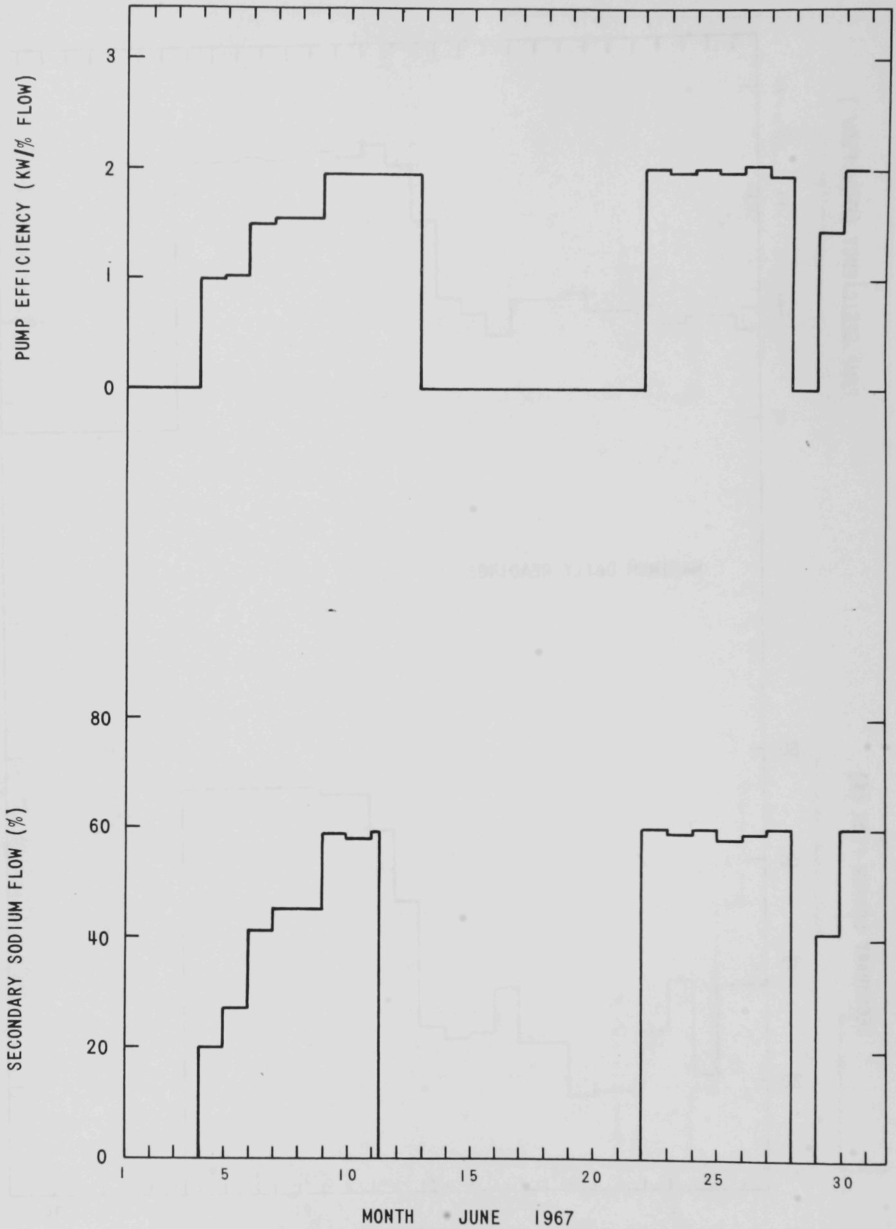
SECONDARY SODIUM FLOW AND PUMP EFFICIENCY

FIGURE 69



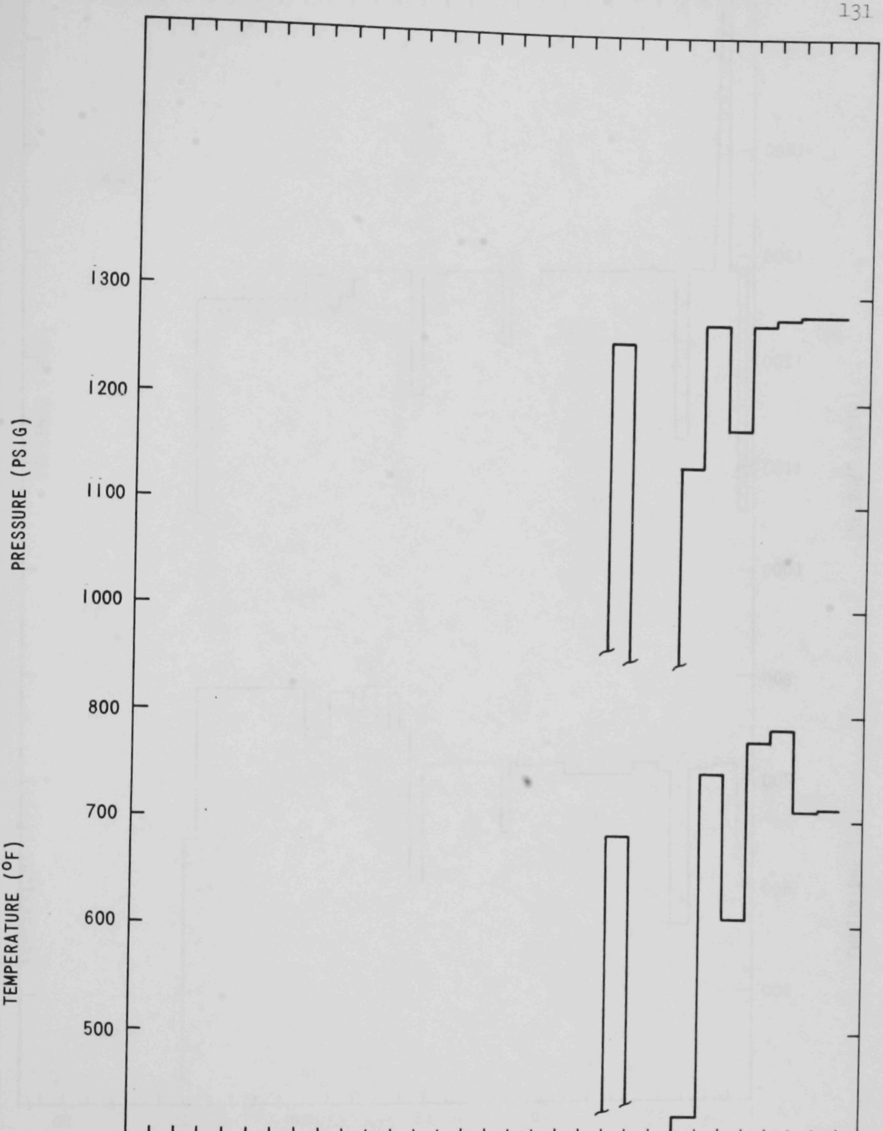
SECONDARY SODIUM FLOW AND PUMP EFFICIENCY

FIGURE 70



SECONDARY SODIIUM FLOW AND PUMP EFFICIENCY

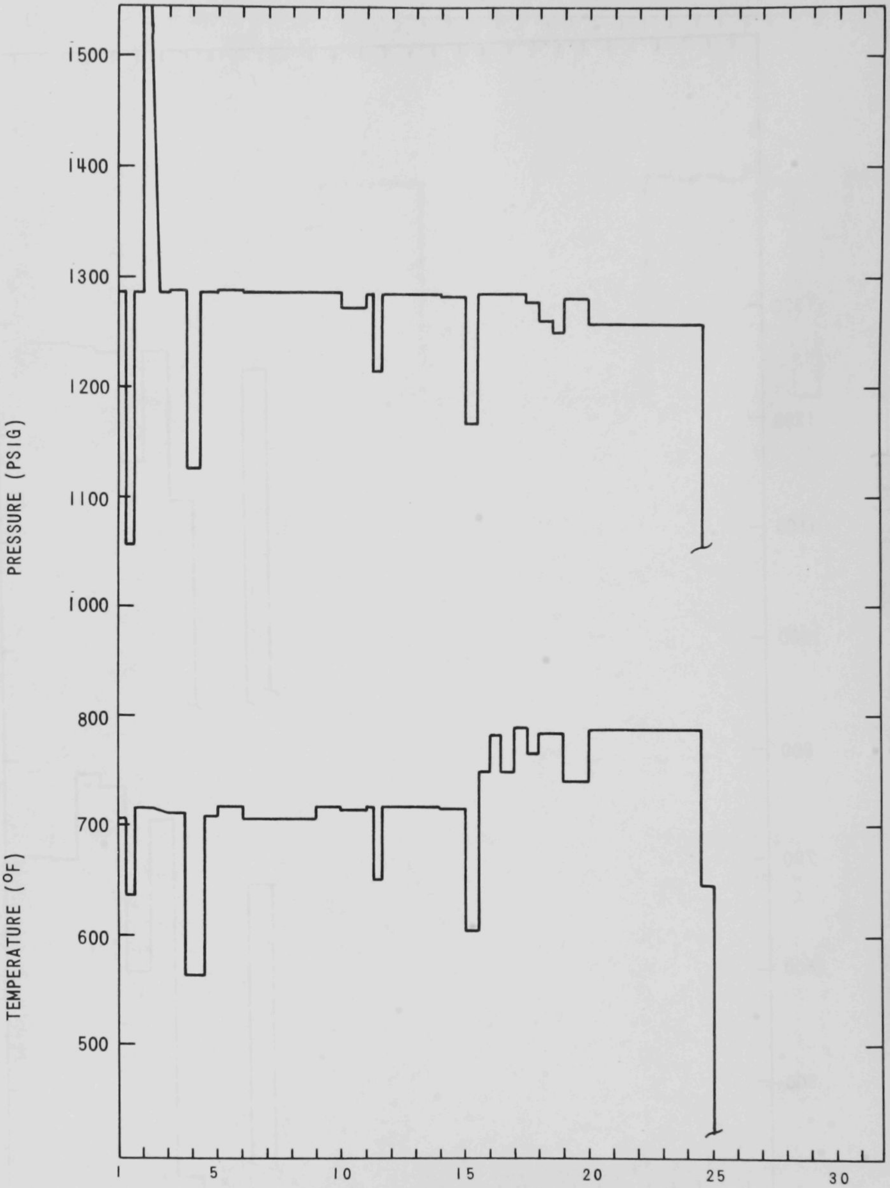
FIGURE 71



MONTH APRIL 1967

STEAM HEADER TEMPERATURE & PRESSURE

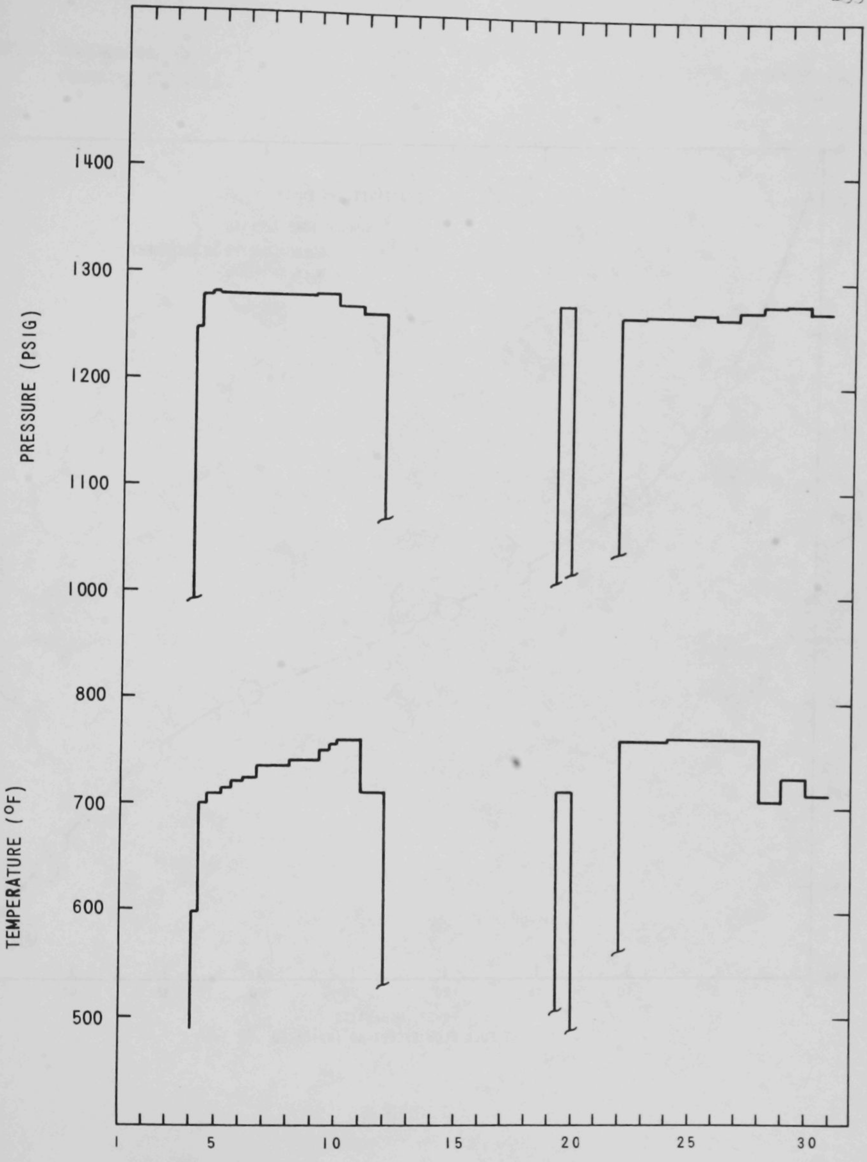
FIGURE 72



MONTH MAY 1967

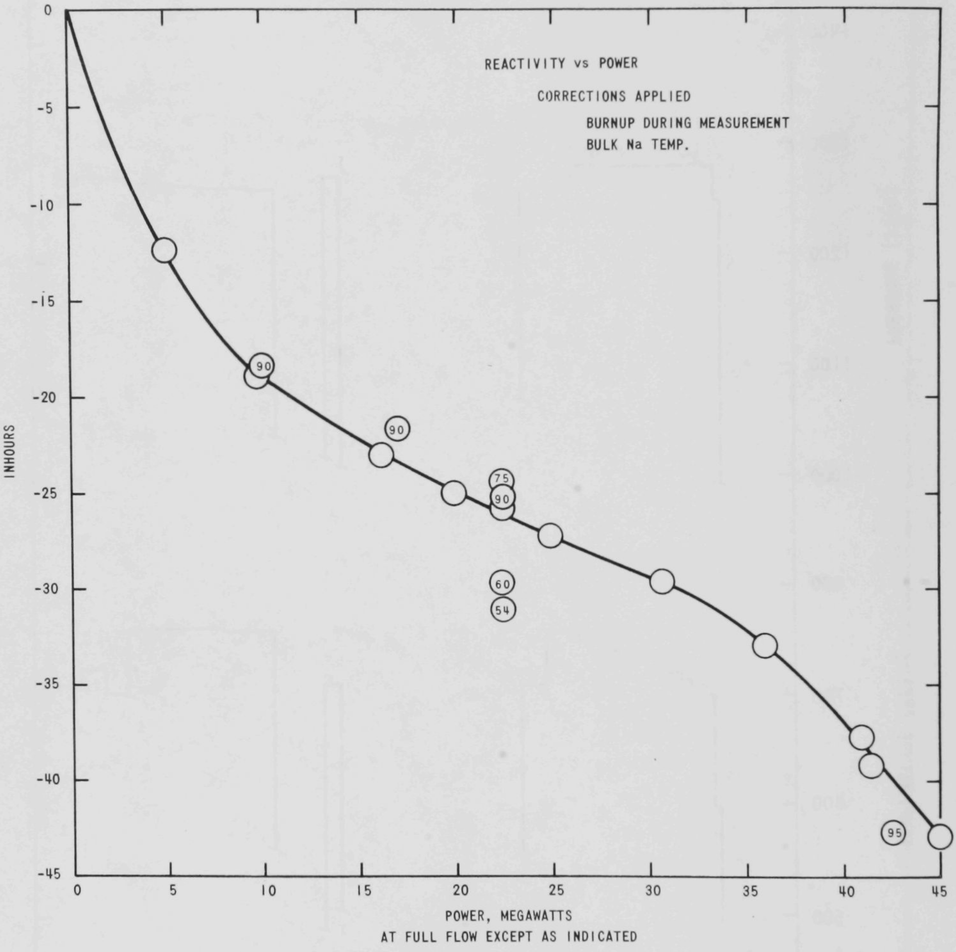
STEAM HEADER TEMPERATURE & PRESSURE

FIGURE 73



STEAM HEADER TEMPERATURE & PRESSURE

FIGURE 74

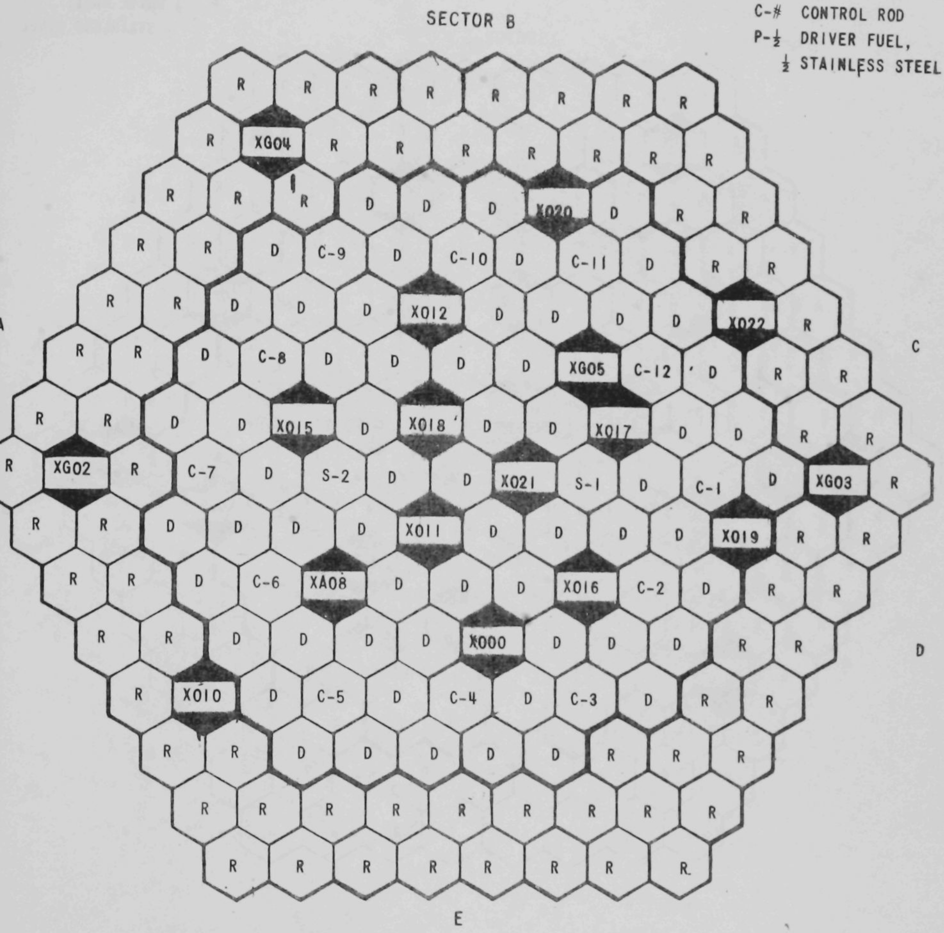


REACTIVITY vs POWER
CORRECTIONS APPLIED
BURNUP DURING MEASUREMENT
BULK Na TEMP.
INHOURS
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
0
5
10
15
20
25
30
35
40
45
90
90
75
90
60
54
95
POWER, MEGAWATTS
AT FULL FLOW EXCEPT AS INDICATED

FIGURE 75

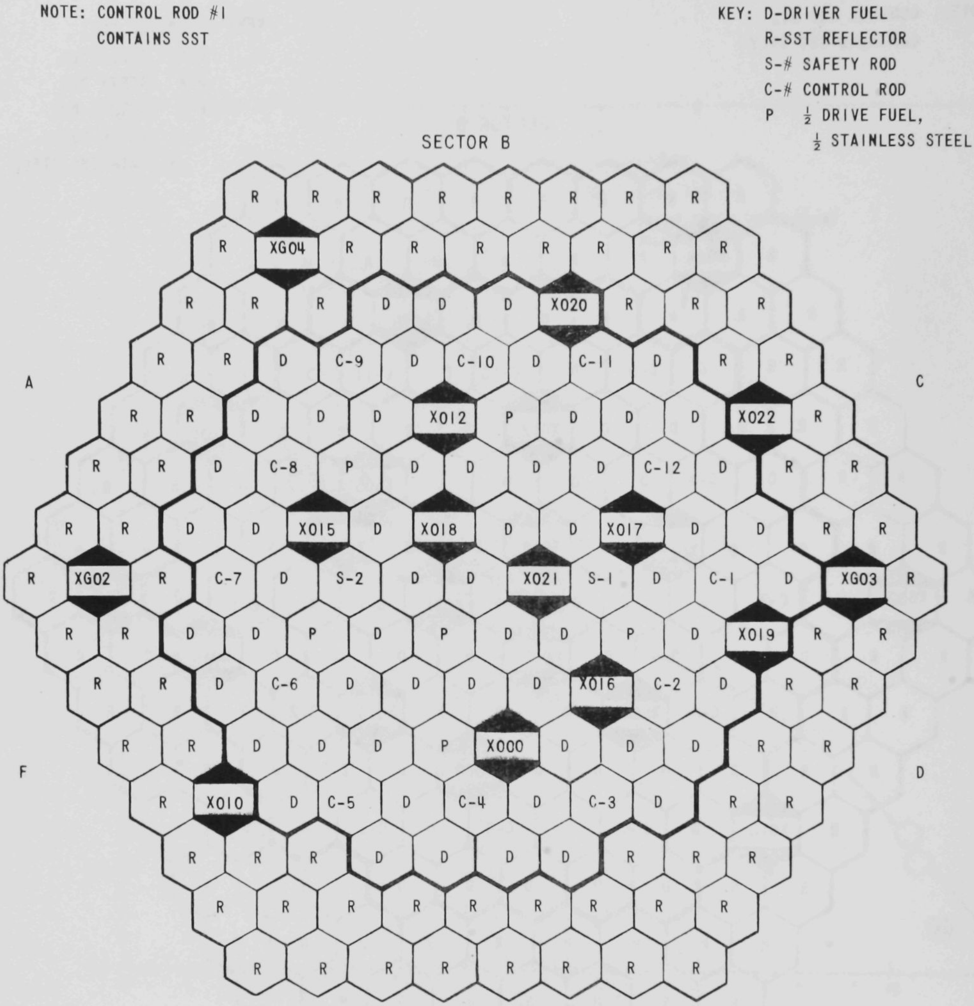
NOTE: CONTROL ROD #1
CONTAINS SST ONLY

KEY: D-DRIVER FUEL
R-SST REFLECTOR
S-# SAFETY ROD
C-# CONTROL ROD
P-½ DRIVER FUEL, ½ STAINLESS STEEL



EBR II EXPERIMENTAL LOADING, APRIL 17, 1967
RUN 25, 88 SUBASSEMBLY CORE

FIGURE 76



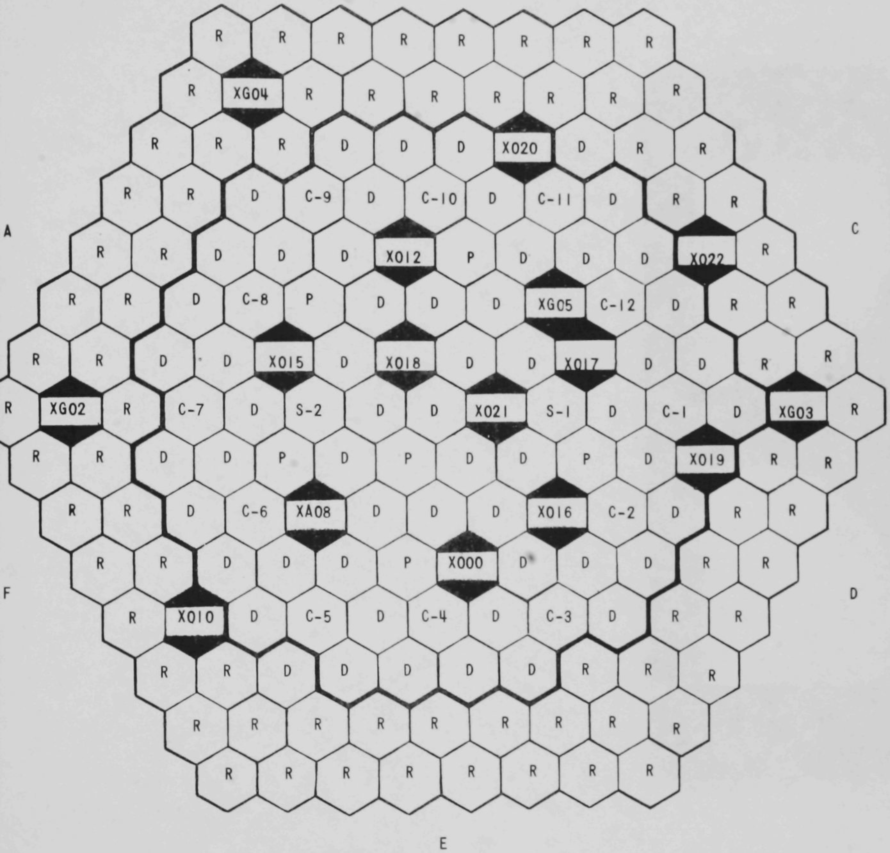
EBR II EXPERIMENTAL LOADING
JUNE 21, 1967
RUN 25, 86 SUBASSEMBLY CORE

FIGURE 77

OTE: CONTROL ROD #1
CONTAINS SST

KEY: D-DRIVER FUEL
R-SST REFLECTOR
S-# SAFETY ROD
C-# CONTROL ROD
P ½ DRIVER FUEL,
½ STAINLESS STEEL

SECTOR B



EBR II EXPERIMENTAL LOADING, JUNE 29, 1967
RUN 25, 86 SUBASSEMBLY CORE

FIGURE 78